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SUITABILITY OF INCLINED PLATE ANCHORS FOR GUYED TRANSMISSION TOWERS

Report No 89-86-K

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ABSTRACT

Tubeco disk anchors with the corrosion protected rod may offer holding capacity of up to 450 kN for guyed structures. An assessment of the anchor suitability for Ontario Hydro transmission applications was examined. Four trial installations were performed followed by full-scale pullout tests at Essa TS. Several factors of influence related to the soil strengths and installation parameters were examined. The following installation parameters were investigated to identify their effects on the foundation: (a) excavation procedure, (b) backfilling operation and (c) angle of inclination.

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SUITABILITY OF INCLINED PLATE ANCHORS
FOR GUYED TRANSMISSION TOWERS

1.0 INTRODUCTION

A full-scale load testing program for inclined plate anchors was performed near Essa TS in a granular soil deposit. Four circular plate anchors, supplied by Tubeco Steel and Manufacturing Incorporated, were installed at the test site shown in Figure 1. Figure 2 shows a schematic of the high capacity anchors for guyed transmission towers supplied by Tubeco Steel and Manufacturing Incorporated. Figure 3 shows a typical plate anchor used in the full-scale testing program. The objective of the field load testing program was to compare the foundation response due to different installation methods for plate anchors.

2.0 SOIL INVESTIGATION

The test site at Essa TS was selected mainly because of the uniformity and homogeneity of the granular deposit. The soil investigation consisted of sampling and performing in situ testing in the native soil and backfill material after the plate anchor installation for comparison purposes. Figure 4 shows the locations of the continuous Shelby, continuous SPT and dilatometer tests performed in the native soil and backfill material for each test anchor. Details of the soil logs and dilatometer tests are contained in Appendix A. Grain-size analysis curves for the native soil and backfill material are shown in Appendix A.

The native soil consisted of a dense to very dense, uniformly graded, fine-grained, silty sand to a depth in excess of 3.5 m. The standard penetration N-values ranged from an average of 40 to 45 blows per 0.3 m in the native soil. The ground water table at the test site was below 4 m in depth.

The native soil was excavated during plate anchor installation and later used as the backfill material during compaction. From the soil investigation of the backfill material, the backfill properties differed from the native soil properties depending on the compaction method used. Table I summarizes the average dry densities of the native soil at two test anchor locations; Anchor No's 1 and 2 respectively. The variability of the in situ density was quite

small (coefficient of variation, COV, = 3-7%) indicating the uniformity of the native deposit across the test site.

Table II summarizes the average dry densities of the backfill material for the four test anchor locations. The variability of the backfill density (COV = 3-12%) was slightly larger than the native soil which also reflects the variability of the compaction technique, since no compaction control was used at the time of the backfilling operation. The compaction efficiency and physical properties of the backfill material will be discussed further in Section 4.3.

3.0 TEST PROGRAM

Different sized test anchors were installed by two different methods to examine the effect of backfilling procedures on the uplift behaviour of plate anchors in granular soil. Two sizes of plate anchors were installed; 0.91 m and 1.21 m diameter. The embedment ratio, D/B, varied from 2.4 to 3.5 for the four test anchors. Table III summarizes the angle of inclination and the method of construction of each test anchor installed.

The proposed angle of inclination for the test anchors was 45^{o} with respect to the horizontal. However, due to difficulties aligning the plate anchor in the excavation, the actual installation angle varied from 34^{o} to 40^{o} with respect to the horizontal (Table III).

4.0 CONSTRUCTION METHODS

The following generally describes the two methods of plate anchor installation performed at Essa TS:

Method (A) - Backfilling by Compaction

A "T"-shaped excavation using a backhoe was made in which the plate-anchor was installed. The trench was backfilled using the excavated material and compacted with a vibrating plate compactor attached to a backhoe.

Method (B) - Concrete Encasement of Plate Anchor

The test anchor was installed in a similar "T"-shaped excavation followed by pouring concrete into the excavated pit and encasing the plate anchor. The remaining excavation was backfilled by tamping the backfill material using a backhoe bucket or using the vibrating plate compactor after 24 hours to allow for the concrete to set.

A third method of installing the plate anchor within an augered hole and backfilling using vertical "rod-like" compactors as recommended by Tubeco Steel and Manufacturing Incorporated was not investigated at this test site due to the unavailability of the suggested equipment (Figure 5).

4.1 Method (A) - Backfilling by Compaction

Details of the procedure used for Anchor No's 1 and 2 are presented as follows:

Steps

(i) A "T"-shaped excavation was made using a backhoe as shown in Figure 6. The main trench for the plate anchor was excavated first, then followed by the slot for the pulling rod.

(ii) The dense, fine-grained silty sand under dry conditions enabled unsupported vertical cuts to be made for the anchor installation as shown in Figure 7. Figures 8 and 9 show the excavation geometry details for Anchors 1 and 2 respectively.

(iii) The plate anchor alignment within the trench is critical for proper installation. Direct contact between the plate anchor and the adjacent native soil in the excavation is desirable to ensure good bearing. Figures 10 to 12 shows the plate anchor alignment procedure.

(iv) After the plate anchor was centred within the trench and the angle of inclination determined, the plate anchor was temporarily tied down to maintain its alignment during the backfilling operation. Also, some backfill material was tamped with the backhoe bucket behind the plate anchor for support prior to the backfilling operation.

(v) A vibrating plate compactor was attached to the backhoe to mechanically tamp the backfill material (Figure 13). The vibrating plate compactor was used to tamp the backfill material in 0.3 and 0.6 m thick lifts using the excavated material.

(vi) The backfilling operation proceeded to ground surface in several lifts until all of the excavated material was compacted into the trench. All of the excavated material, when compacted into the trench, was 0.15 to 0.20 m below ground surface, so extra material was required to fill the remainder of the pit to grade.

(vii) During the backfilling operation, no compaction control was performed other than to ensure all of the excavated soil was backfilled during compaction. The backfill material was sampled and tested as part of the soils investigation for comparison purposes in Section 4.3.

4.2 Method (B) - Concrete Encasement of Plate Anchor

Details of the procedure used for Anchor No's 3 and 4 are presented as follows:

Steps

(i) to (iii) A similar "T"-shaped excavation was made, except with a slightly different geometry. Figures 14 and 15 show the geometry of the excavated trench with an additional "sump" for the concrete to encase the plate anchor.

(vi) The excess and/or loose material in front of the plate anchor was removed or tamped to ensure proper concrete encasement of the plate anchor and minimize soil contaminant of the concrete.

(vii) After the plate anchor was centred within the trench and the angle of inclination determined, the plate anchor was temporarily tied down to maintain its alignment during the concrete pour.

(viii) A ready-mix batch of Portland Type 10 cement with 20 mm aggregate (compressive strength of 30 MPa) was used to encase the plate anchors. The concrete mix was poured from the concrete truck into the trench. Figure 16 shows the concrete placement for plate Anchor No's 3 and 4.

(ix) A concrete vibrator was used to ensure proper encasement of the plate anchor (Figure 17a). Anchor No 3 used 0.09 m^3 and Anchor No 4 used 0.06 m^3 of concrete to cover the tops of the plate anchors.

(x) The concrete was covered with straw to prevent freezing and allowed to cure for 24 hours (Figure 17b).

(xi) The remaining excavation was backfilled to ground surface using a vibrating plate compactor in 0.3 to 0.6 m thick lifts. At Anchor No 4, the vibrating plate compactor was damaged, so the excavation was tamped using only the backhoe bucket.

4.3 Mechanical Compaction Assessment of Backfill Material

An assessment of the backfilling operation in comparison with the native soil and standard Proctor tests was made. From the soils investigation, an evaluation of the backfill material consisted of the following: (a) dry density measurements obtained from Shelby tube samples, (b) relative density, (c) strength properties and (d) moisture content.

Table IV compares the average dry density of the backfill material for Anchor No's 1 and 2 with the in situ native soil density and with the maximum dry density from the standard Proctor test. Anchor No's 1 and 2 were backfilled and mechanically tamped using a vibrating plate compactor. A ratio of the dry density of the backfill to the maximum dry density was about 90%. In other words, 90% compaction efficiency was achieved with the vibrating plate compactor used for Anchor No's 1 and 2 with respect to the standard Proctor test. The natural moisture content of the silty sand deposit was near the optimum moisture content (4 - 8%) which aided the compaction of the excavated material.

Figure 18 shows the difference in the average N-values recorded for the native soil compared to the backfill material. In general, the relative density and strength properties associated with the backfill material was considerably less than the native soil as inferred from the differences in N-values. The native soil deposit increased both in relative density and N-values with depth between 3 m and 6 m.

Considerable scatter in the N-values was evident for both the native and backfill material above 3 m depth (Figure 18). The large scatter of the N-value, coefficient of variance about 25 to 50%, can be attributed to the variability associated to the Standard Penetration Test procedures and spatial variability of the granular deposit across the test site.

The dilatometer provides an indication of relative density by the magnitude of the dilatometer modulus, Ed. Figure 19 shows the different Ed values measured in the backfill and native soil for the four test anchors. Figure 20 shows the variation of Ed in the backfill related to the different methods of compaction used on site. The dilatometer modulus profile indicates the following (Figure 20):

(a) The native soil gradually increases in Ed and similarly in relative density with increased depth.

(b) Ed is uniform or consistent in magnitude (ie small scatter in Ed with depth) for the native soil.

(c) The backfill material compacted using the vibrating plate was denser than the native soil in the top 1.0 m. However, between 2 and 3 m depth, directly above the plate anchor, considerable scatter in Ed is noted. Therefore, the variability in Ed indicates the relative density of the backfill material is variable as well. Since no compaction control was performed during the backfilling operation, loose or uncompacted zones in the backfill appeared at depth as indicated by the variability in Ed. Due to the presence of the plate anchor, a physical obstruction of the vibrating plate compactor to tamp near the plate anchor resulted.

(d) Compacting the backfill material with the backhoe bucket resulted in the lowest recorded Ed values and similarly, the lowest relative density. Tamping using the backhoe bucket does not provide sufficient mechanical force to compact the backfill material to obtain densities

equal to the native soil. The mechanical compaction achieved using the vibrating plate compactor was better than the backhoe bucket tamping.

The dilatometer modulus profiles of the backfill and native soil (Figure 20) provide more information than the SPT N-values (Figure 18) in the assessment of the backfilling operation at the test anchor locations.

4.4 Difficulties Encountered During Plate Anchor Installation

Some difficulties were encountered during the installation of the test anchors using Methods (A) and (B). The following lists some of these difficulties encountered:

(a) Alignment of the plate anchor at the desired angle of inclination of 45^{o}.

(b) The large diameter plate anchor caused damage to the PVC corrosion sheathing during placement in the excavation (Figure 21).

(c) Control of the 0.3 to 0.6 m thickness of lifts placed during the backfilling operation using the vibrating plate compactor.

(d) Control of the excavation geometry using a 0.6 m wide bucket on the backhoe.

(e) Proper seating of the washer on the pulling rod with the anchor plate is important to avoid excessive slack in the system as noted in Anchor No 1.

(f) The soil investigation revealed differences in efficiency depending on the type of mechanical compaction used; the backhoe bucket is less efficient than the vibrating plate compactor. The vibrating plate compactor achieved 90% of the maximum dry density obtained from the standard Proctor tests at this test site.

(g) Presence of uncompacted and/or loose pockets in the backfill due to the lack of compaction control could lead to excessive foundation deflections.

(h) The fine-grained native soil with a uniform grading resulted in poor compactability characteristics during the backfilling operation even though the natural moisture content was near the optimum moisture content.

Other Potential Difficulties:

(i) Competent native soil conditions are required to minimize the excavation size and caving conditions.

(j) The presence of a high water table would complicate the excavation by requiring dewatering and/or shoring.

(k) Excavation of the "sump" geometry for ready mix concrete might not be possible in poor soil conditions or require formwork to contain the concrete.

(l) Insulation of the ready mix concrete was required to prevent freezing of the batch after pouring in cold weather conditions.

(m) Vibration of the concrete mix was required to ensure proper encasement of the plate anchor.

(n) Contamination of the concrete mix due to caving soil conditions.

5.0 TEST ARRANGEMENT

The typical reaction frame set-up for the inclined uplift test of the circular plate anchors consisted of a pair of 18 m I-beams resting on 2.5 m x 1.2 m timber pads. Two 900 kN (100 ton) capacity hollow ram jacks were used to apply the uplift loads to the test anchor. The hydraulic jacks were supported on a steel plate and angled seats on the long I-beams. A bulldozer at one end of the I-beams provided the reaction against the horizontal shear loads resulting from the applied inclined loading (Figures 22 and 23). Figure 23 shows the special coupling adaptor used to attach the 44 mm (1-3/4" diameter) pulling rods to the 30 mm diameter high strength plate anchor rod.

The applied load was in-line with the angle of inclination of the installed plate anchor. The loads were applied in increments of 20 kN. Each increment of loading was maintained for 5 minutes or until significant movement of the plate anchor had occurred. The load was cycled once or twice at approximately 50% of the anticipated maximum anchor capacity. At higher load steps, each increment of load was maintained for 10 minutes or longer depending on the creep response. The maximum applied load was restricted to the allowable strength of the anchor rod (340 kN). Details of the field load testing and setup can be found elsewhere/1/.

6.0 INSTRUMENTATION OF TEST ANCHORS

The test anchors were instrumented to identify the extent of soil uplift movements surrounding the plate anchor and to identify the mode of failure. The movement of the soil mass surrounding the test anchor was monitored by tell-tale rods at different locations and depths as shown in Figure 24. The tell-tales consisted of 6 mm steel rods in a PVC cased hole (25 mm diameter) installed to various depths and spacing. The uplift movement of the tell-tale rods was measured by displacement potentiometers mounted on a supported batter board (Figures 25 and 26). The ground heave and subsurface soil movements was recorded for each tell-tale as the applied incremental loading proceeded. Details of the instrumentation installed for each test anchor is contained in Appendix B.

The applied inclined load versus anchor rod displacement curve for each test anchor was obtained. The applied load was measured using a load cell mounted on the hollow ram hydraulic jack and a displacement potentiometer was attached

to the inclined pull-rod of the test anchor. Figure 27 shows the x-y plotter which provided the real-time load displacement curve as the field load testing proceeded.

An attempt was made to measure the expected horizontal soil movements due to the inclination of the plate anchor. A 63.5 mm diameter flight auger was used to install vertical holes to a depth of 4.5 m which was below the expected soil movements. A temporary PVC access casing (50 mm ID, 63.5 mm OD) was installed to be filled with a dry cement powder. Just prior to the field load testing, the temporary PVC casing was to be removed thus leaving a dry cement column in the hole. In this manner, any horizontal soil movements would be recorded in the deformed vertical cement column. After the field load testing, the deformed cement column was to be saturated and allowed to set for examination upon excavation. Due to the relatively small magnitude of the plate anchor displacements, the dry cement columns were abandoned since the horizontal soil movements would also be small.

7.0 FIELD LOAD TEST RESULTS

Table V summarizes the anchor capacities for each test anchor tested. The test anchor response differed, depending on the method of installation; Method "A" - backfilling and Method "B" - Concrete Block. The results of the field load testing for each test anchor are tabulated in Appendix C.

7.1 Foundation Response

Figure 28 depicts the load-displacement curves for Anchor No's 1 and 2 embedded in the backfill material compacted with a vibrating plate compactor (Method "A"). Figure 29 depicts the load-displacement curves for Anchor No's 3 and 4 encased in a concrete block (Method "B"). The following observations can be made from these load-displacement curves (Figures 28 and 29):

(a) The total anchor rod displacements are larger for backfilled Anchor No's 1 and 2 installed by Method "A" than Anchor No's 3 and 4 encased in concrete installed by Method "B".

(b) Anchor No 1 showed large deflections partly due to the slack in the pulling rods and partly due to poor compaction or compressibility of the backfill in front of the plate anchor. Note the anomalous convex-shape of the initial portion of the loading curve which indicates the lack of stiffness in the soil-plate anchor system (Figure 28). Also, a 9 kN seating load was applied to Anchor No 1 resulting in 152 mm slippage of the pulling rod prior to the curve shown in Figure 28.

(c) Anchor No 2 showed a linear increase in the plate anchor resistance with each increasing load step which differs from Anchor No 1.

(d) Anchor No's 1 and 2 exhibited a minor amount of creep movement under maximum applied loading.

(e) The maximum applied load for Anchor No's 1 and 2 was restricted to 350 kN which is the rated mechanical strength of the 30 mm diameter anchor rod by Tubeco Steel and Manufacturing Incorporated.

(f) The cycled portion of the load-deflection curves for Anchor No's 1 and 2 reveal the linearly elastic behaviour of the plate anchors due to unloading and reloading. This linearly elastic response of the plate anchors provides an indication of the relative stiffness achieved in the backfill material by the compaction efforts of the vibrating plate compactor. Since the reloading portions for each cycle was approximately linear and parallel, the elastic response of the backfill indicates the relative stiffness of the system remained the same before and after cycling.

(g) Test Anchor No's 3 and 4, which were encased in concrete as installed by Method (B), exhibited a "stiffer" response than test Anchor No's 1 and 2 installed by Method (A) - backfill compaction.

(h) The displacement of 18 mm recorded for Anchor No 4 was caused by the bending of the pulling rod due to a difference in the angle of pulling (Table III). This was confirmed by only 1 mm displacement recorded by two vertical telltales monitoring the top of the anchor encased in concrete.

(i) Anchor No 3 displaced only 3 mm under a maximum applied loading of 300 kN, which is near the rated mechanical strength of the anchor rod.

(j) Anchor No 4 resulted in a mechanical failure of the special adaptor during testing due to bending from the difference in the angle of inclination of the plate anchor and angle of pulling (Table III).

(k) The foundation response of Anchor No's 3 and 4, in terms of higher anchor capacity and smaller displacements, can be attributed to the enlarged concrete bearing surface (2.3 m wide x 1.4 m high x 1.2 m long) in comparison to the direct buried plate anchor dimensions.

(l) Anchor No 3 did not exhibit significant creep movements under maximum applied loading.

(m) The cycle of unloading and reloading performed on Anchor No 3 indicated the stiffness of the system did not change significantly prior to and after the cycled loading.

7.2 Monitored Soil Movements

The telltale instrumentation installed for each test anchor monitored the soil movements at various depths and distances from the plate anchor. Tell-tales installed vertically monitored the soil uplift movements below that depth. Other telltales were installed at known angles of inclination in order to monitor the soil movements along the line of pulling to estimate the horizontal/lateral component of soil movements. However, these inclined telltale rods did not function well since the magnitudes of the vertical

component of inclined movements monitored were smaller than the uplift movements measured by the vertical telltales. The results of the telltale measurements are tabulated in Appendix C.

Figure 30 depicts the approximate extent of soil movement surrounding Anchor No 1 under maximum applied loading. The maximum uplift movements measured in the soil mass monitored by the telltales are plotted for the maximum applied load step. The soil mass adjacent to the shearing surface resulted in measurable subsidence or settlement as the plate anchor uplifted the volume of soil shown in Figure 30. The maximum soil uplift movement of 3 mm occurred directly above the plate anchor measured by telltale No 7 (Figure 30).

Figure 31 shows a similar zone of soil movement surrounding Anchor No 2 under the maximum applied loading. The lateral influence at the ground surface and the volume of soil mass uplifted appears larger for Anchor No 2 than Anchor No 1 (Figure 30 and 31). This can be attributed to the lower angle of inclination for Anchor No 2 (at 34^{0}) than Anchor No 1 (at 43^{0}). Figure 31 shows that beyond the volume of soil mass uplifted by the plate anchor, similar small settlements of the soil beyond the shearing surface occurred for Anchor No 2 as noted for Anchor No 1. The maximum soil uplift movement of 5 to 10 mm occurred directly in front of the plate anchor at a distance of 1.0 to 1.3 m away (telltales T9 and T12 in Figure 31).

The observed modes of failure for the test anchors were found to be dependent on the method of installation. In the case of Anchor No's 1 and 2, which were placed in backfill material and compacted (ie Method "A"), the failure mode was a local bearing capacity-type in combination with some uplift of the soil mass at depth surrounding the anchor plate (Figures 30 and 31). For Anchor No's 3 and 4, which were encased in concrete (ie Method "B"), neither general nor local failure of the soil mass was achieved because of the increased anchor capacity due to larger bearing surface of the concrete block encasing the test anchor.

8.0 CONCLUSIONS

The installation method has significant effect on the behaviour of plate anchors in terms of the uplift capacity and magnitude of displacements. Four plate anchors supplied by Tubeco Steel and Manufacturing Incorporated were tested in this full-scale foundation study. The following factors should be considered in the selection of plate anchors to resist inclined uplift loads:

(a) Workability and compactability of the native soil to be used as backfill material. For example, at Essa TS, the fine-grained, uniformly-graded, granular soil does not compact well.

(b) High ground water table or poor/incompetent soil conditions will require dewatering and/or shoring during excavation.

(c) Backfill control is necessary to ensure proper compaction; particularly in front of the plate anchor; to minimize excessive anchor displacements and to increase mobilization of soil resistance.

(d) Alignment of the plate anchor is important since variations in the angle of inclination can affect the anchor capacity, in addition to over-stressing the structural members as with Anchor No 4.

(e) Proper seating of the disc washer on the anchor rod with the anchor plate is important to avoid excessive slack in the system as noted for Anchor No 1.

(f) The installed angle of inclination of the plate anchor is important since it affects the capacity and displacment response of the foundation subjected to uplift loads.

(g) Control and inspection is required in the field if the plate anchor is to be encased in concrete.

Of the two methods of installation investigated, Method (B); plate anchor encased in concrete developed a higher capacity with minimum displacements. Also, the installation procedure for Method (B) is simplified, thus making it adaptable for varying soil conditions along a transmission tower line.

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TABLE 1

DRY DENSITY OF NATIVE SOIL

ANCHOR NO.	1	2
HOLE NO.	1B	2B
* AVERAGE DRY DENSITY (kg/m^3)	1717	1552
* STANDARD DEVIATION OF DRY DENSITY (kg/m^3)	123	46
** COEFFICIENT OF VARIATION OF DRY DENSITY (%)	7.2	2.9

* AVERAGE AND STANDARD DEVIATION OF DRY DENSITY CALCULATED FROM SHELBY TUBE SAMPLES

** COEFFICIENT OF VARIATION (COV) DEFINED AS STANDARD DEVIATION DIVIDED BY MEAN OF THE SAMPLE SET

TABLE 2

DRY DENSITY OF BACKFILL MATERIAL

ANCHOR NO.	1	2	3	4
HOLE NO.	1D	2C	3A	4C
* AVERAGE DRY DENSITY (kg/m^3)	1531	1462	1540	1529
* STANDARD DEVIATION OF DRY DENSITY (kg/m^3)	58	171	99	106
** COEFFICIENT OF VARIATION OF DRY DENSITY (%)	3.8	11.7	6.4	6.9

* AVERAGE AND STANDARD DEVIATION OF DRY DENSITY CALCULATED FROM SHELBY TUBE SAMPLES

** COEFFICIENT OF VARIATION (COV) DEFINED AS STANDARD DEVIATION DIVIDED BY MEAN OF THE SAMPLE SET

NOTE - ANCHOR #1, 2 AND 3 COMPACTED USING VIBRATING PLATE
ANCHOR #4 COMPACTED USING BACKHOE BUCKET

TABLE 3

PLATE-ANCHOR DIMENSIONS

ANCHOR NO.	ENCASED IN	DIAMETER (m)	EMBEDMENT RATIO D/B	INCLINATION OF ANCHOR ROD INSTALLED AT (DEG. TO HORIZONTAL)	ANGLE OF PULLING (DEG. TO HORIZONTAL)
1	BACKFILL	1.21	2.4	46	40
2	BACKFILL	0.91	3.4	34	34
3	CONCRETE	1.21	3.4	34	34
4	CONCRETE	0.91	3.4	31	40

TABLE 4

DRY DENSITIES FOUND IN-SITU
COMPARED WITH BACKFILL MATERIAL

ANCHOR NO.	1	2	NOTES
(1) BACKFILL MATERIAL			(1) FROM SHELBY TUBE SAMPLES TAKEN IN BACKFILL MATERIAL (2) FROM SHELBY TUBE SAMPLES TAKEN IN NATIVE SOIL (3) RESULTS OF FULL PROCTOR TEST ON BAGGED SAMPLES (4) COMPARISON OF BACKFILL DENSITY WITH IN-SITU NATIVE SOIL (5) COMPARISON OF BACKFILL DENSITY WITH FULL PROCTOR
AVG DRY DENSITY (kg/m^3)	1531	1461	
COV OF DRY DENSITY (%)	4	12	
(2) NATIVE SOIL			
AVG DRY DENSITY (kg/m^3)	1717	1551	
COV OF DRY DENSITY (%)	7	3	
AVG MOISTURE CONTENT (%)	7	8	
STANDARD DEVIATION OF MOISTURE CONTENT (%)	± 4	± 4	
(3) MAXIMUM DRY DENSITY	1732	1638	
OPTIMUM MOISTURE CONTENT (%)	3.5	8	
(4) RATIO OF BACKFILL DENSITY TO NATIVE SOIL DENSITY	0.89	0.94	
(5) RATIO OF BACKFILL DENSITY TO MAXIMUM DRY DENSITY	0.88	0.89	

TABLE 5

TEST ANCHOR CAPACITIES

ANCHOR NO.	DIAMETER (m)	ENCASED IN	PULLOUT CAPACITY (kN) AT 25 mm DEFLECTION	MAXIMUM LOAD APPLIED (kN)	DEFLECTION AT MAXIMUM LOAD (mm)
1	1.21	BACKFILL	20*	340	125*
2	0.91	BACKFILL	260	340	32
3	1.21	CONCRETE	>300	>300	2
4	0.91	CONCRETE	>220	>220	18**

* ANCHOR NO 1 - SIGNIFICANT SLIPPAGE OF PULL ROD BEFORE SEATING

** ANCHOR NO 4 - PULLING ROD BENDING DURING TESTING DUE TO DIFFERENCE IN THE ANGLE OF PULLING AND THE ANCHOR ROD

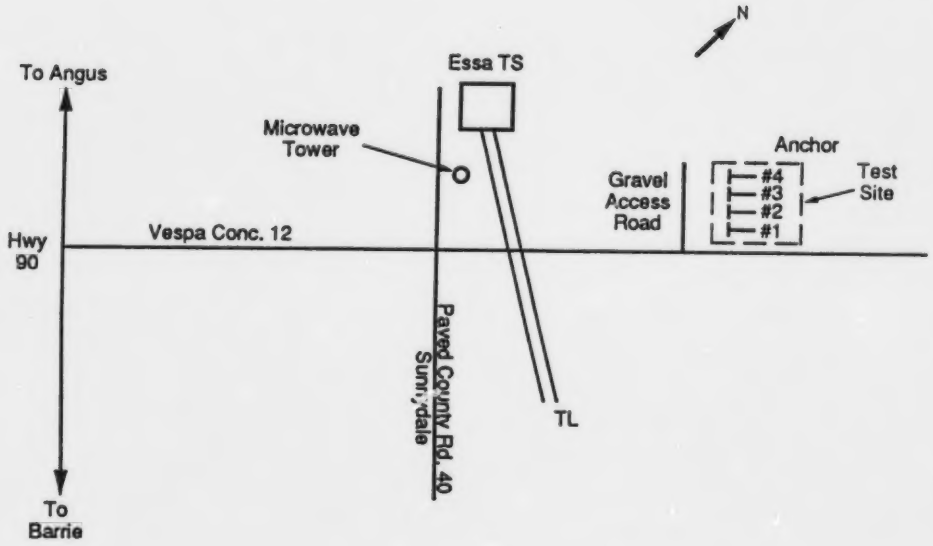
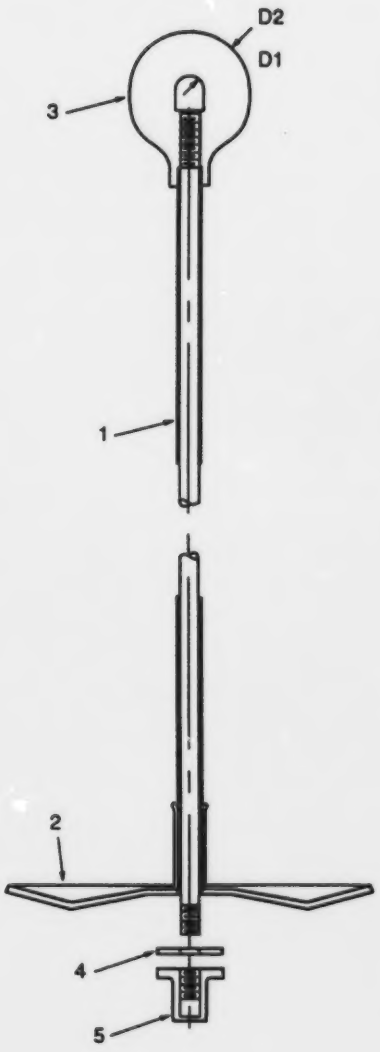


FIGURE 1

LOCATION OF TEST SITE AT ESSA TS



1. 1 1/4" x 15' high strength rod
   120 + kip ultimate strength
   120 psi minimum yield (20% elongation
   each end threaded 2 3/4"
   Rod coated with mastic asphalt covered with
   plastic liner

2. Anchor disk
   1/2" formed plate
   100 + kip ultimate strength
   Holding strength with 15' rod and proper installation
   36" disk anchor
   Class 4-5 soil - 100,000#
   Class 6 soil - 100,000#

3. Cast steel oval eye (galvanized)
   200 kip ultimate strength
   plastic liner recesses into eye
   D1 - 1 3/4" diameter
   D2 - 1 1/2" diameter
   Other eyes also available

4. Insulating washer

5. Heavy cast steel nut
   4" diameter flange
   Nut capped to seal threads
   2 3/4" thread depth

FIGURE 2

HIGH STRENGTH TRANSMISSION ANCHOR
EARTH CONE FORMING DISK ANCHOR WITH CATHODIC PROTECTION
(FROM TUBECO STEEL & MFG., INC.)

179224-RD
JA 12 DISK

FIGURE 3a

TYPICAL PLATE ANCHOR
USED IN FULL-SCALE
TESTING OF INCLINED ANCHORS

FIGURE 3b

A WASHER (YELLOW) AND
NUT WAS THREADED TO
THE PULLING ROD

179174-RD
Bart 7 disk

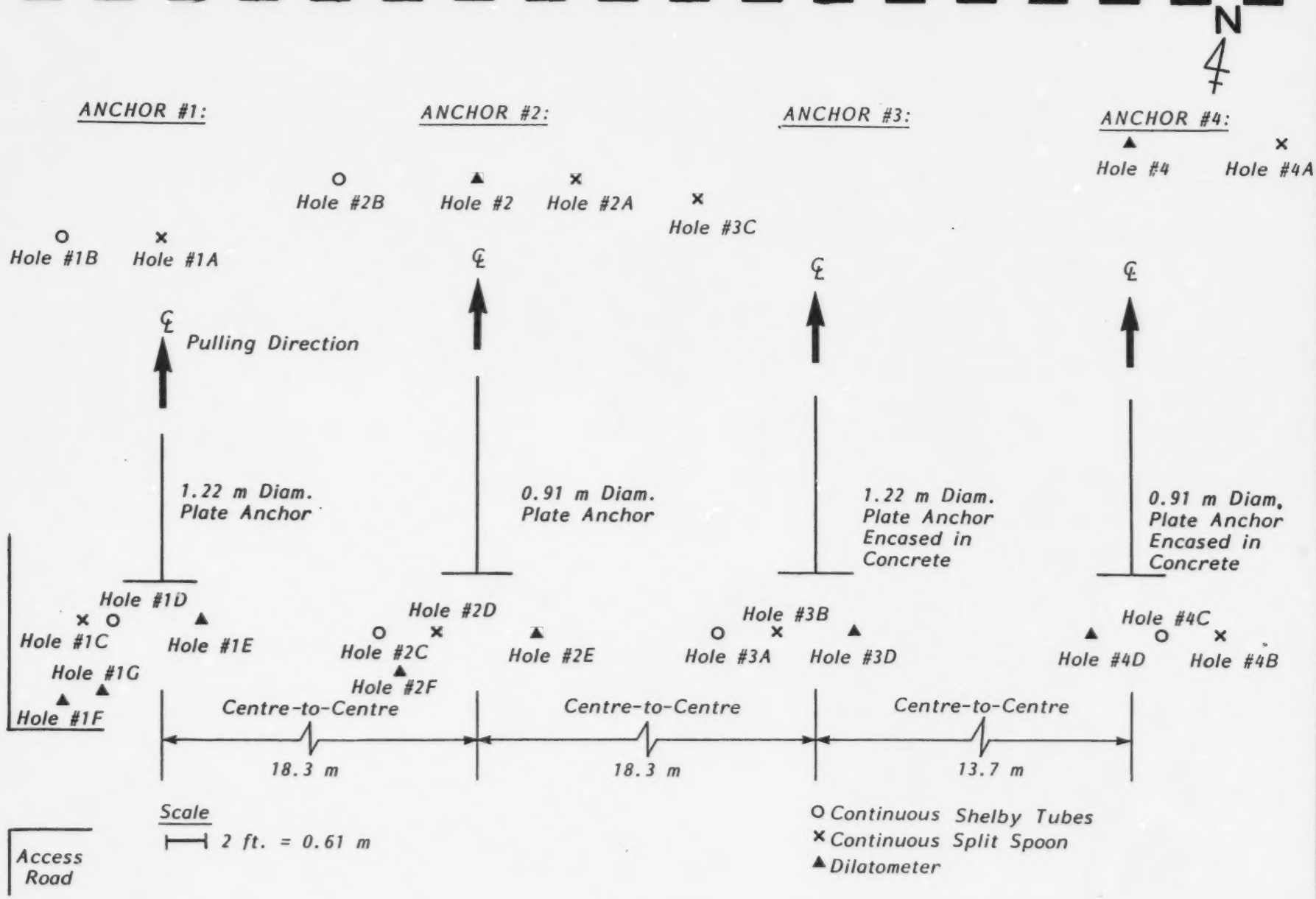
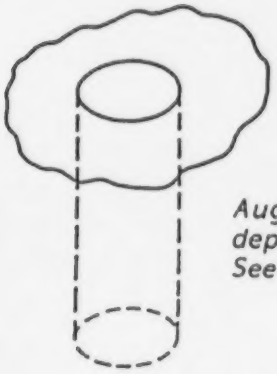


FIGURE 4
ESSA TS ANCHOR TESTS - SOIL INVESTIGATION

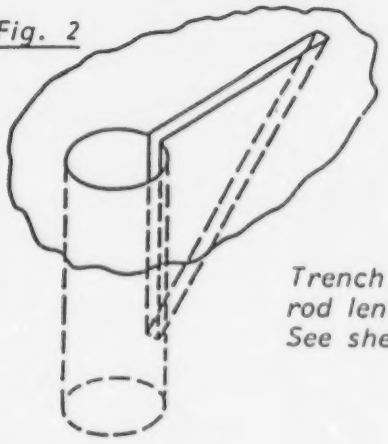
179204-RD

Fig. 1



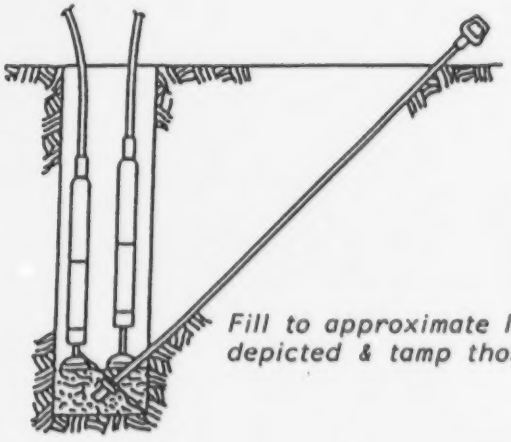
Auger hole to required depth for rod used. See sheet 2.

Fig. 2



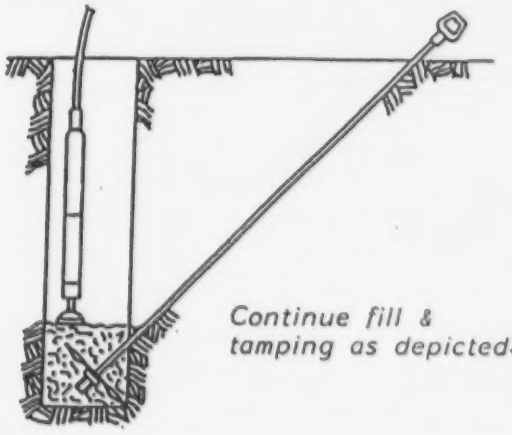
Trench rod slot to match rod length & guy angle. See sheet 2.

Fig. 3



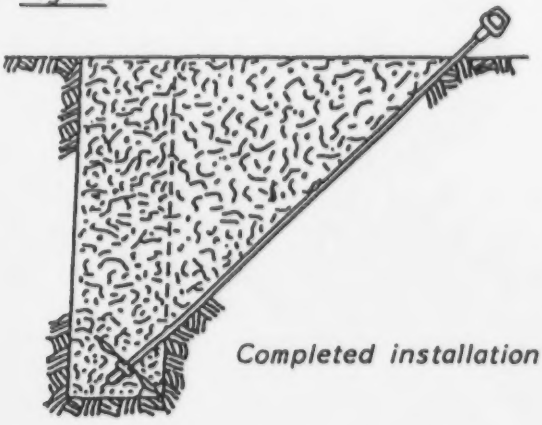
Fill to approximate level depicted & tamp thoroughly.

Fig. 4



Continue fill & tamping as depicted.

Fig. 5



Completed installation

Fig. 1. Hole can be augered for 16" through 36" disk anchors.

Fig. 2. A trenching machine will expidite rod slot.

Fig. 3. Nut & insulating washer should be pulled tight against disk.

Fig. 3. & 4. The first fill should be moist & compactable.

The first 3 layers of fill & tamping are by far the most important. Care should be taken to tamp behind anchor disk as well as on top.

FIGURE 5
DISK ANCHOR INSTALLATION
(FROM TUBECO STEEL & MFG., INC.)

FIGURE 6

THE PLATE ANCHOR INSTALLATION CONSISTED OF A "T" SHAPED EXCAVATION MADE USING A BACKHOE WITH A 0.6 m WIDE BUCKET

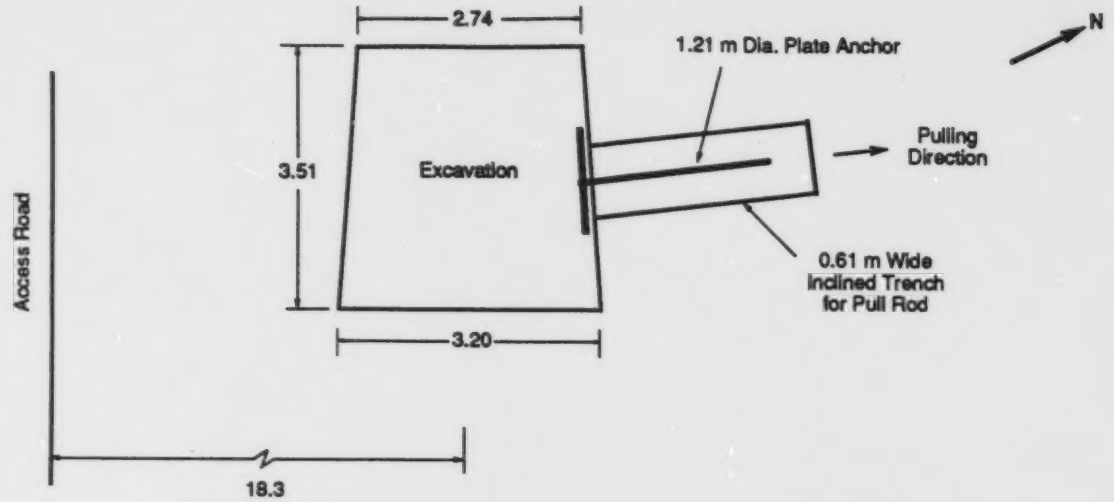
179157-RD
Bart 7 disk

FIGURE 7

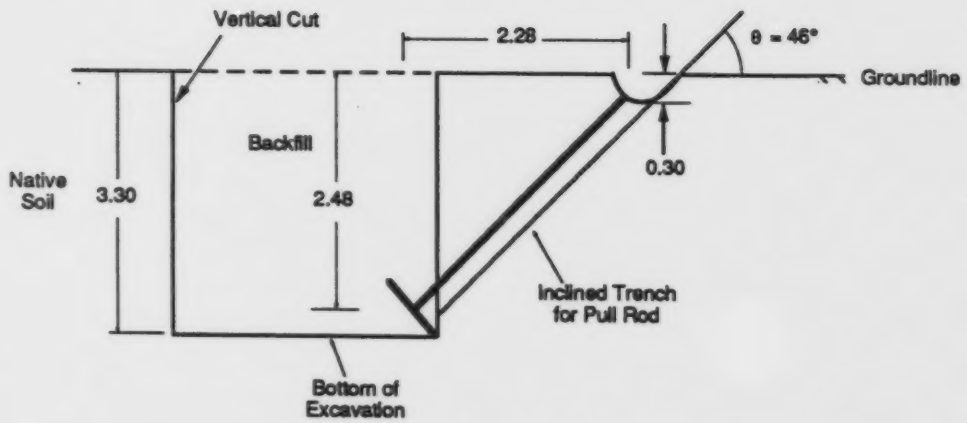
VERTICAL CUT/FACE OF A TYPICAL EXCAVATION IN DENSE TO VERY DENSE SILTY SAND FOR THE EMBEDMENT OF THE PLATE ANCHOR

179158-RD
Bart 7 disk

Plan View



Cross-Section



Inclination of Plate Anchor, θ = 46°

All Dimensions in metres

1 m

FIGURE 8

INSTALLATION OF PLATE ANCHOR - ANCHOR #1

179156-S12-RD

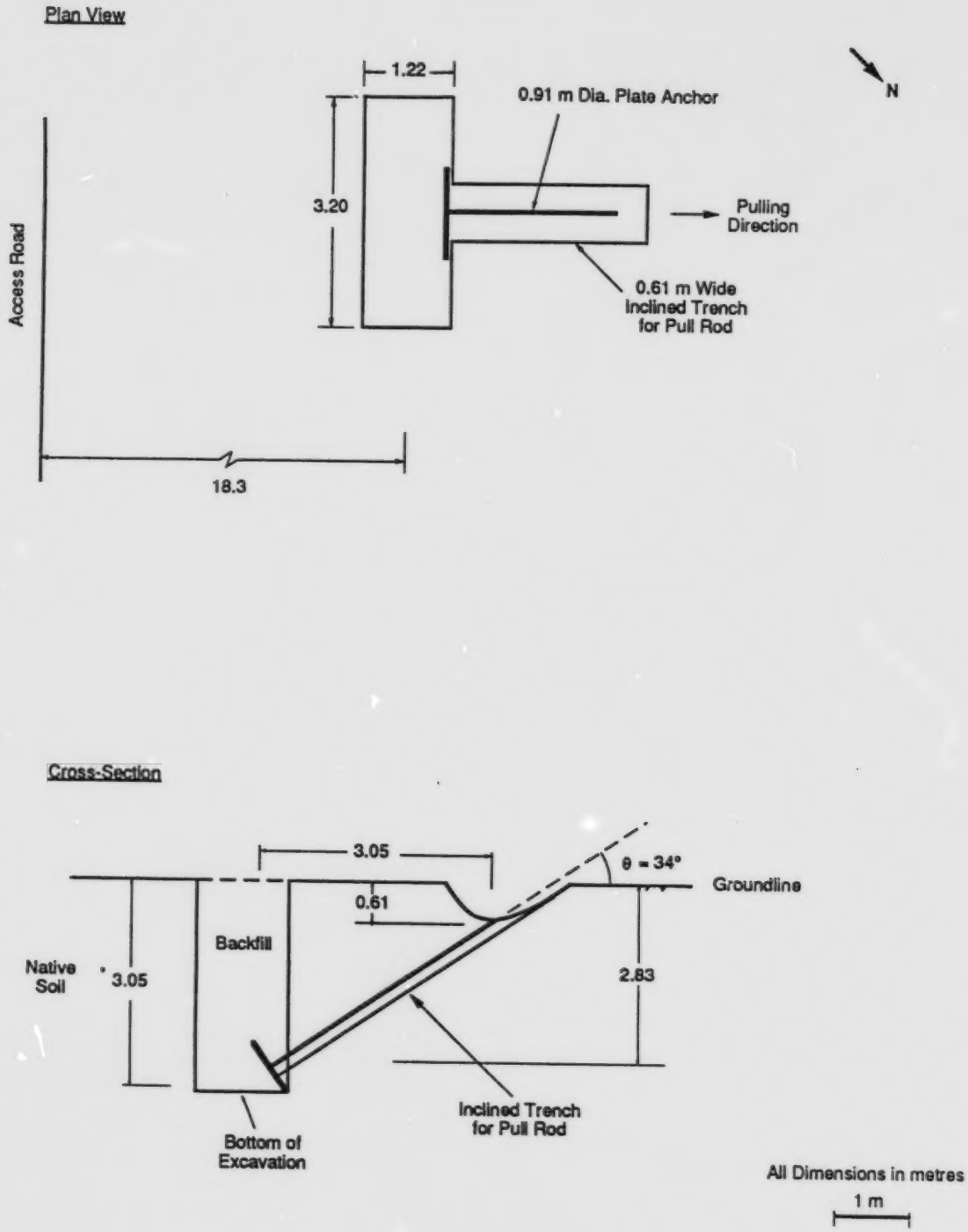


FIGURE 9

INSTALLATION OF PLATE ANCHOR - ANCHOR #2

179180-S12-RD

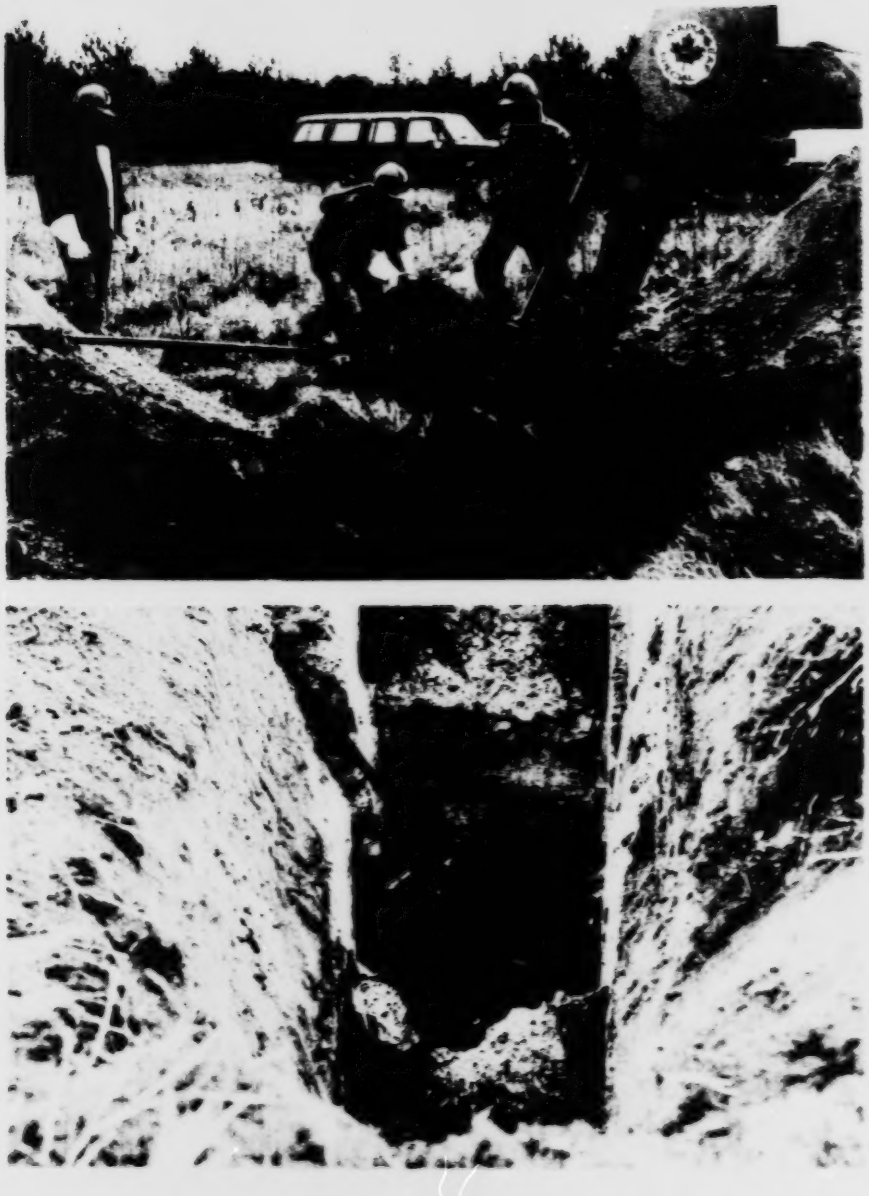


FIGURE 10

PLACEMENT OF THE PLATE ANCHOR INTO THE EXCAVATION

179161-RD
Bart 7 disk

FIGURE 11a

ANCHOR PLATE AND PULLING ROD ASSEMBLY PLACED IN THE TRENCH

FIGURE 11b

ALIGNMENT OF PLATE ANCHOR IS CRITICAL IN THE PLACEMENT PROCEDURE TO ENSURE GOOD BEARING AGAINST THE NATIVE SOIL ADJACENT TO THE EXCAVATION

179162-RD
Bart 7 disk

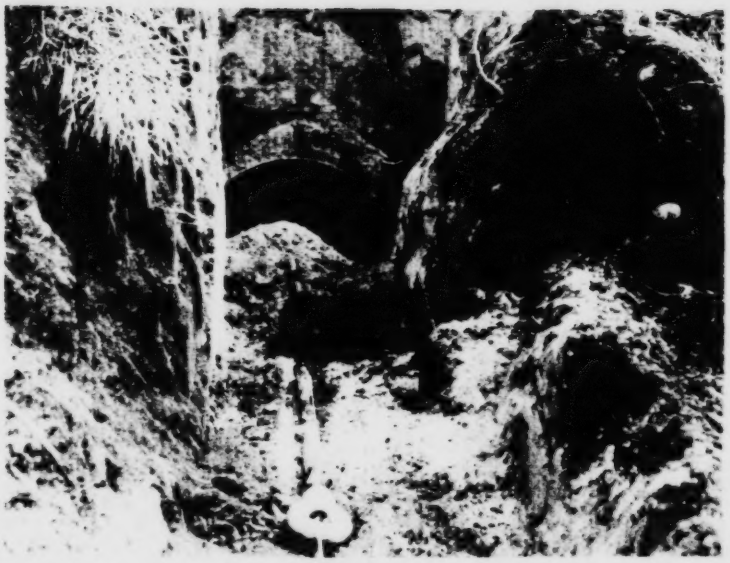


FIGURE 12a

SOME LOOSE MATERIAL CAVED IN FRONT OF THE PLATE ANCHOR DURING INSTALLATION

FIGURE 12b

DIRECT CONTACT BETWEEN PLATE ANCHOR AND NATIVE SOIL ON THE ADJACENT FACE OF THE EXCAVATION IS DESIRABLE

179163-RD
Bart 7 disk

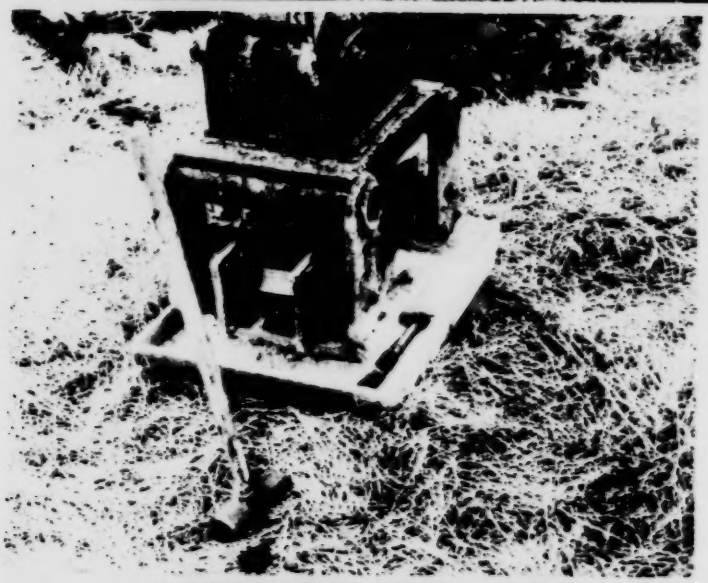


FIGURE 13

A VIBRATING PLATE COMPACTOR WAS USED FOR THE BACK-FILLING OPERATION. THE BACKHOE BUCKET (FORD 555A L - 47 X L) WAS DETACHED TO MOUNT THE HYDRAULIC DRIVEN VIBRATING PLATE COMPACTOR (WIDTH 0.46 m X LENGTH 0.61 m)

179164-RD
Bart 7 disk

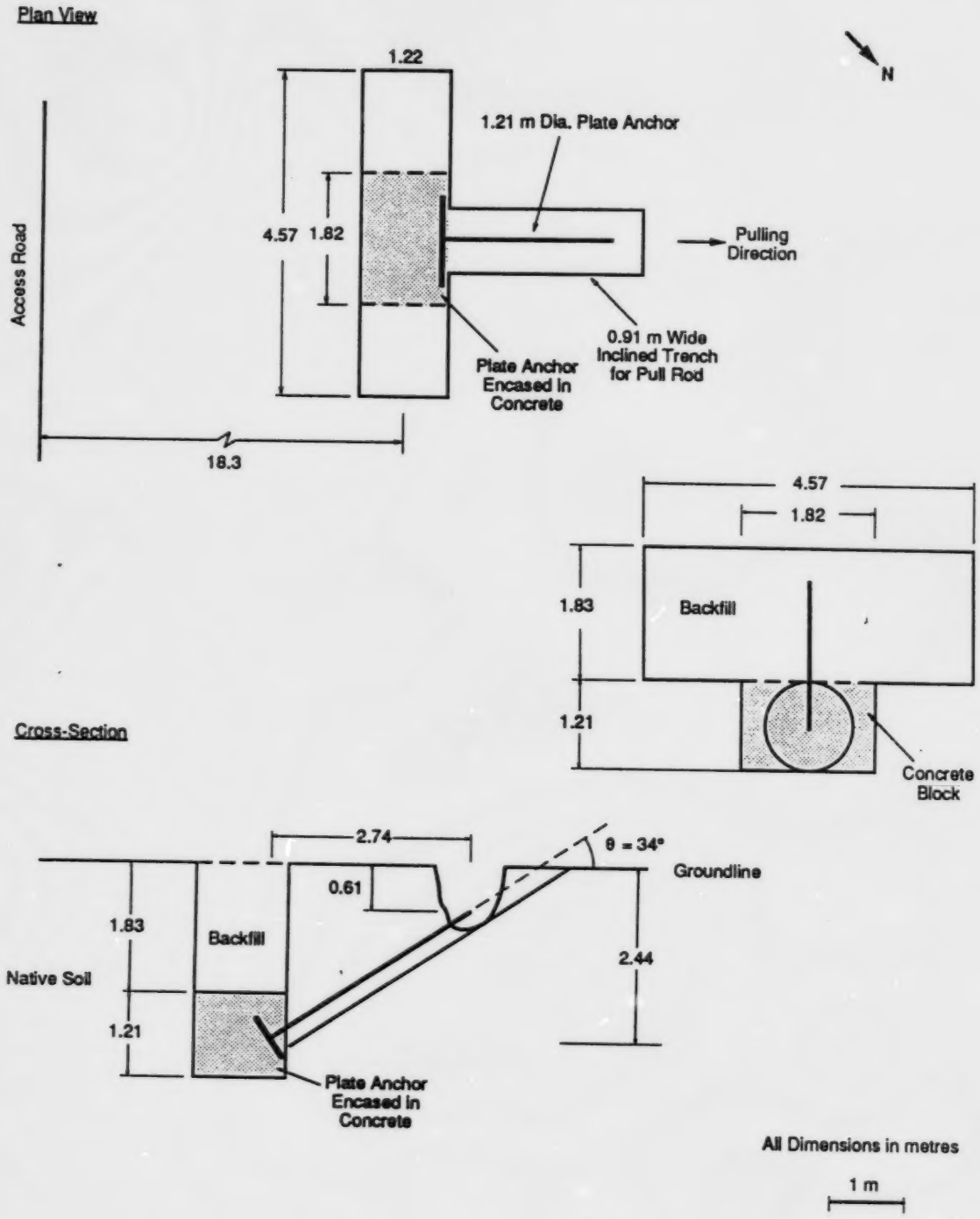


FIGURE 14

INSTALLATION OF PLATE ANCHOR - ANCHOR #3

179225-RD
JA 12 DISK

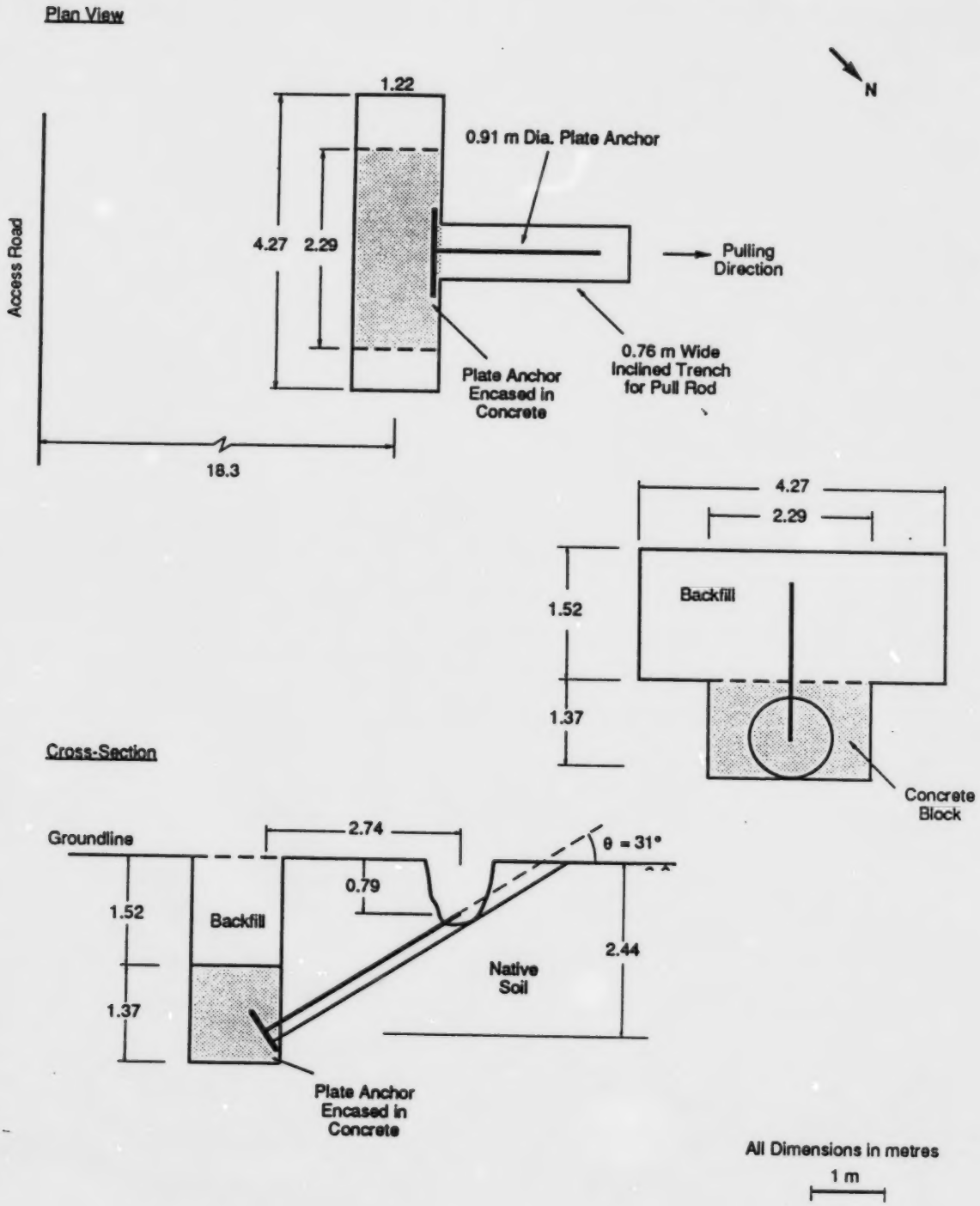


FIGURE 15

INSTALLATION OF PLATE ANCHOR - ANCHOR #4

179226-RD
JA 12 DISK

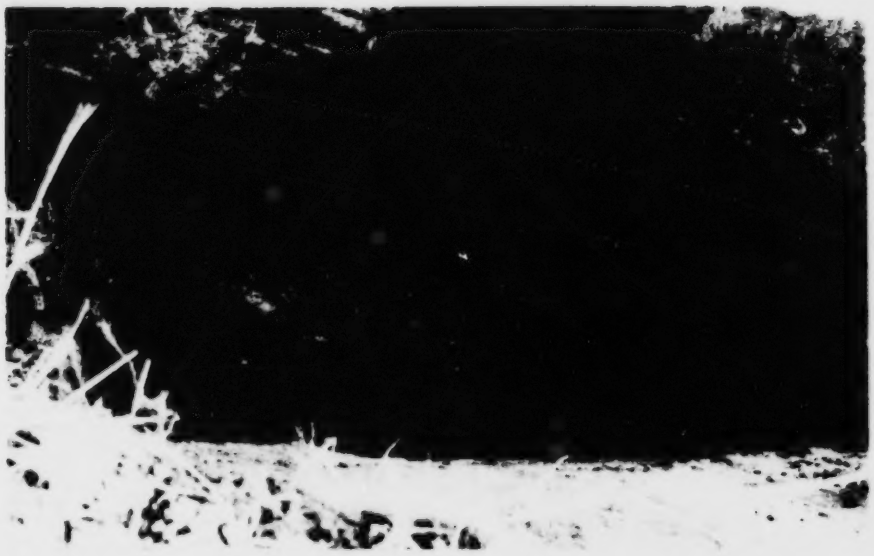


FIGURE 16

CONCRETE PLACEMENT. ENCASED THE TEST PLATE ANCHORS NO'S 3 AND 4

179173-RD
Bart 7 disk

FIGURE 17a

A VIBRATOR WAS USED TO ENSURE PROPER ENCASEMENT OF THE PLATE ANCHOR IN CONCRETE

FIGURE 17b

THE CONCRETE WAS COVERED WITH STRAW TO PREVENT FREEZING OVERNIGHT

179172-RD
Bart 7 disk

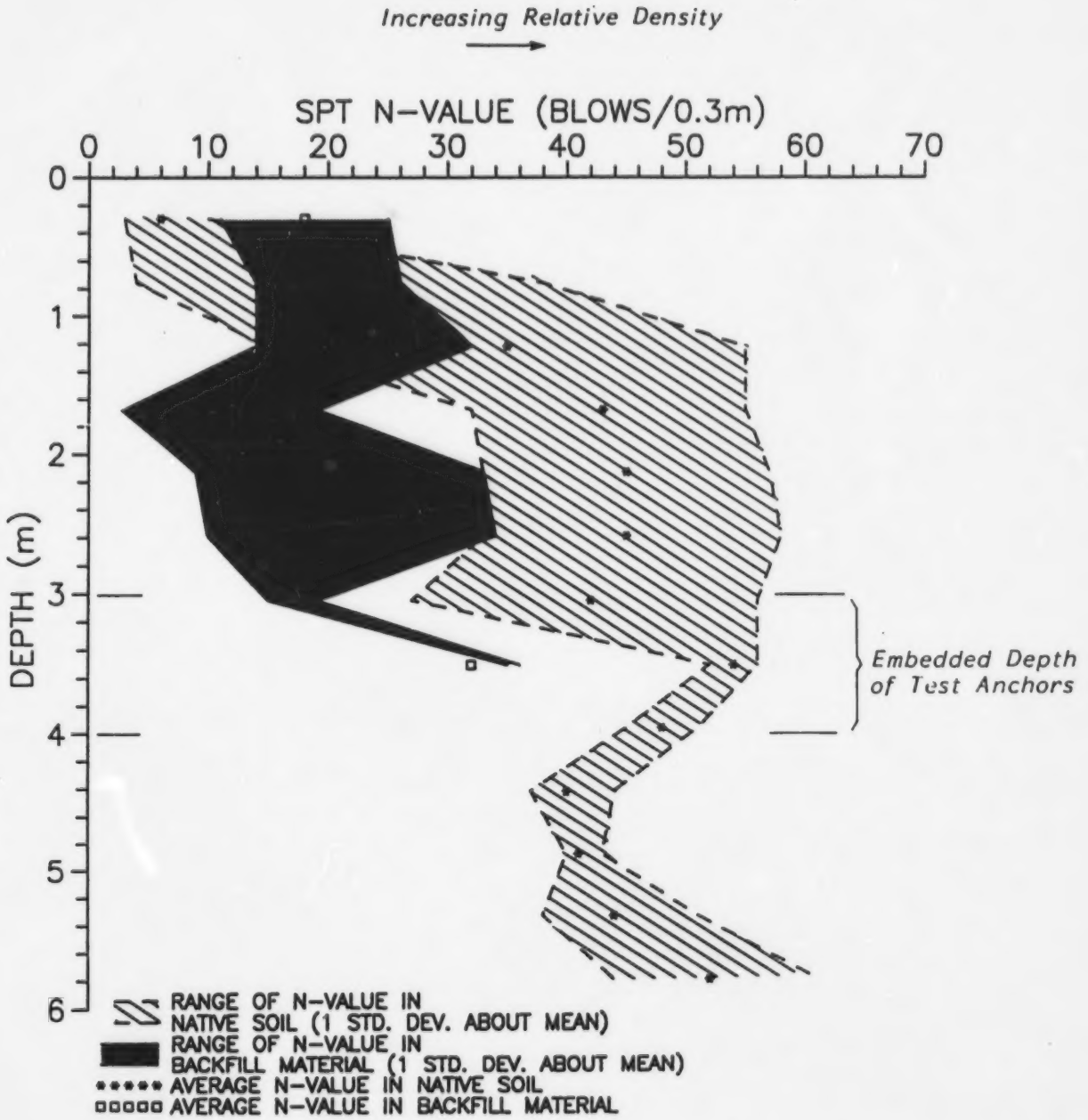


FIGURE 18 COMPARISON OF SPT VALUES IN NATIVE AND BACKFILL MATERIAL

179148-RD

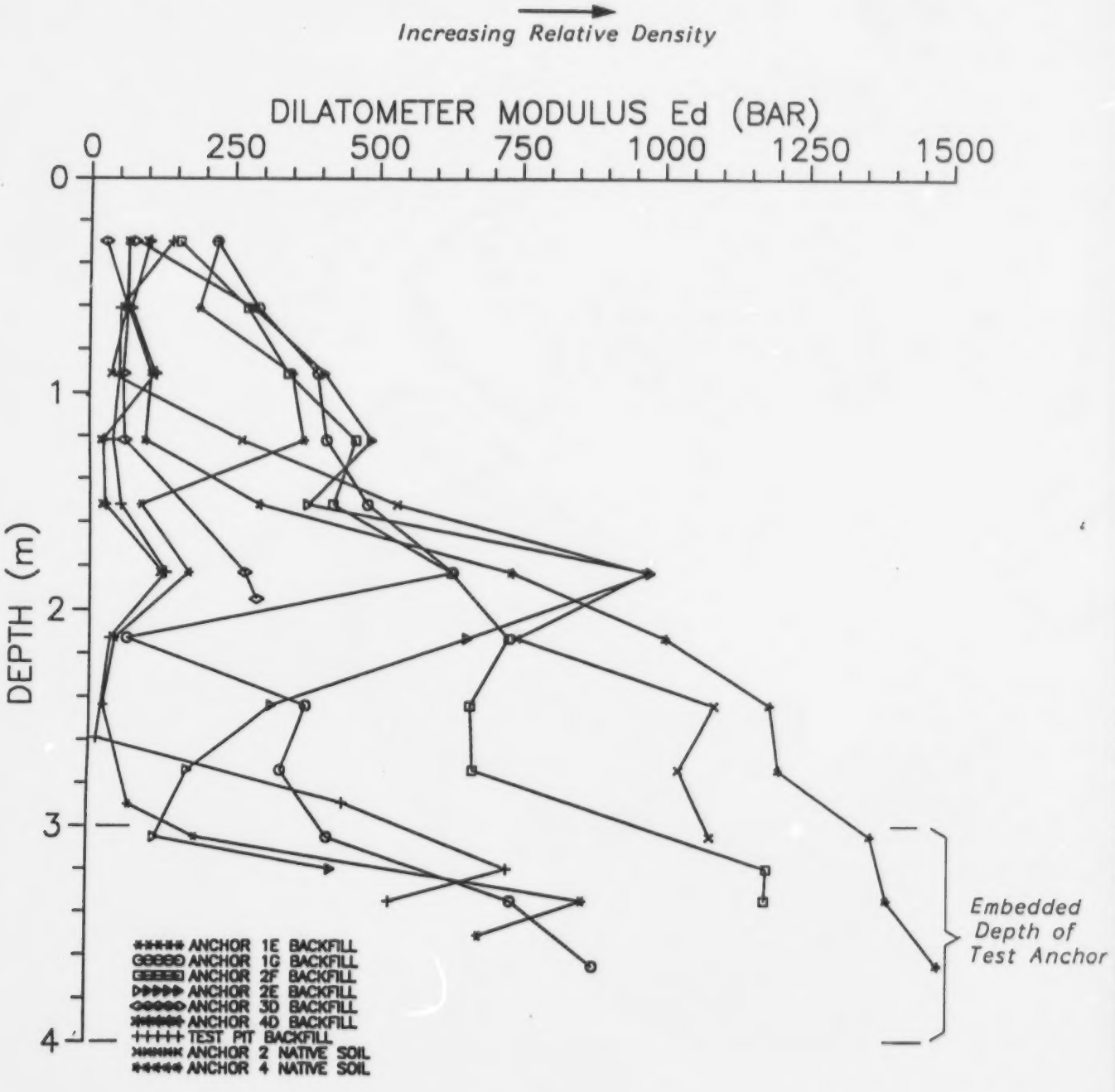


FIGURE 19 COMPARISON OF Ed VALUES IN NATIVE AND BACKFILL MATERIAL

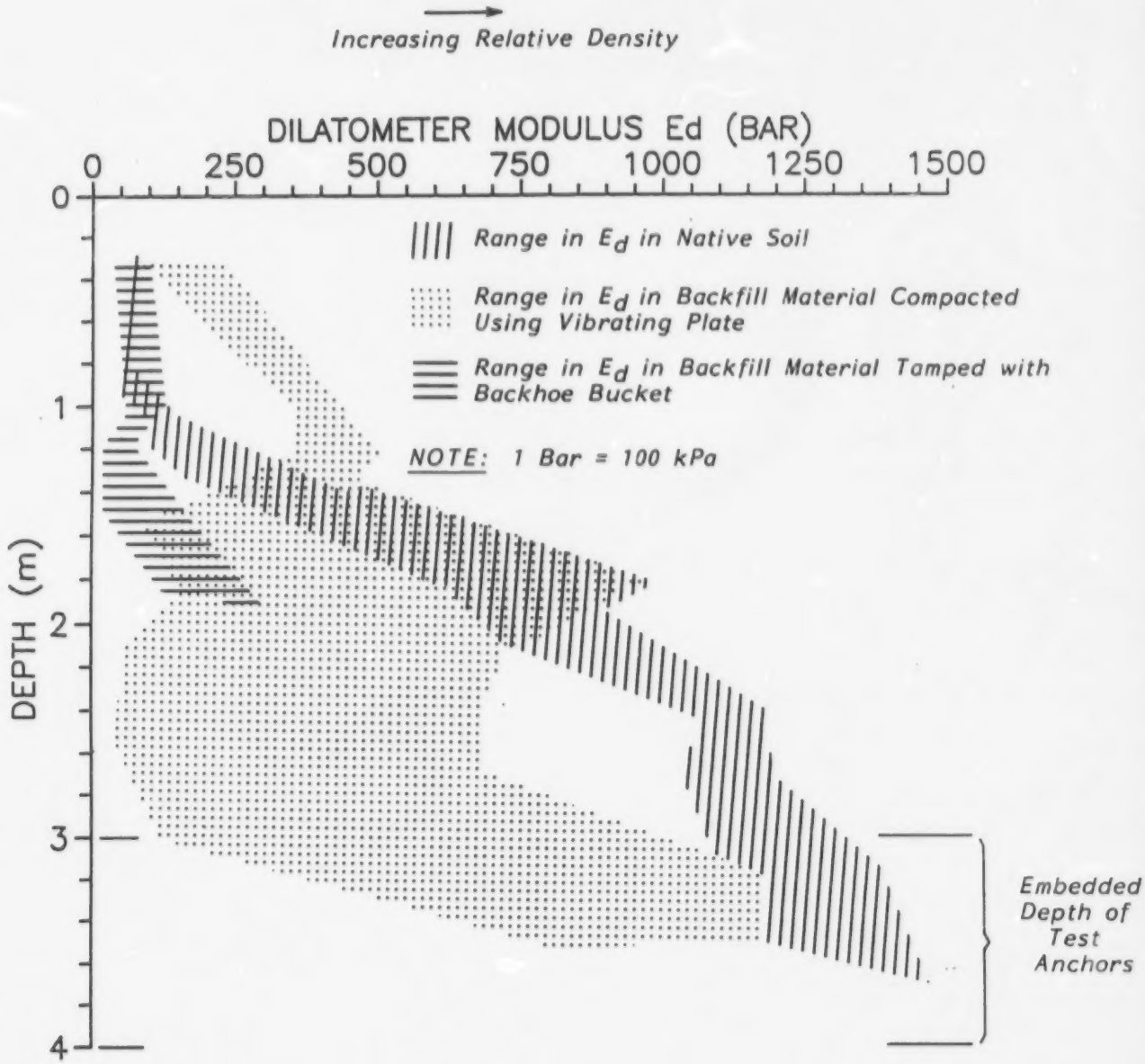


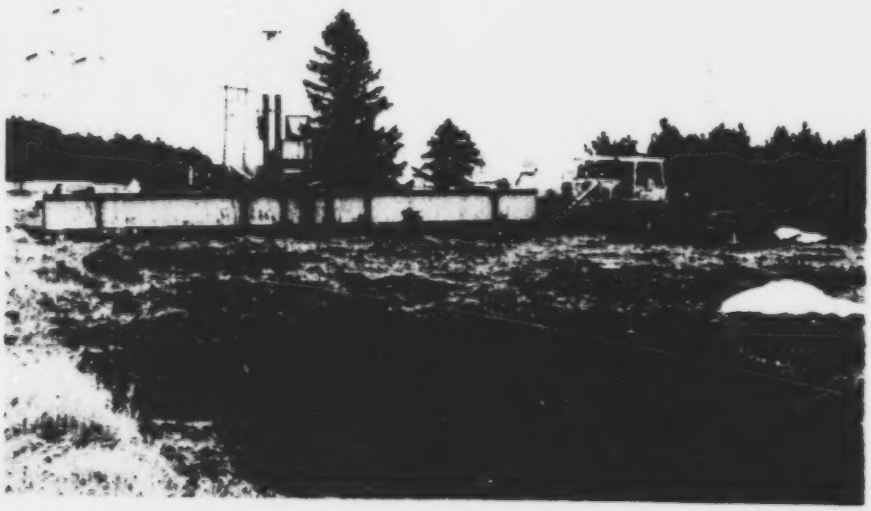
FIGURE 20 COMPARISON OF Ed VALUES IN NATIVE AND BACKFILL MATERIAL

Damaged PVC Coating on Pulling Rod
(The pulling rod does not have a retaining
nut in front of the circular plate)

FIGURE 21

PVC CORROSION PROTECTION SHEATH WAS DAMAGED DURING ANCHOR PLACEMENT. IT WAS REMOVED FROM THE ANCHOR ROD

179171-RD
Bart 7 disk



A Bulldozer (D7) was Used as the Horizontal Reaction to Prevent the I-beams from Sliding During Testing

FIGURE 22

TYPICAL SET-UP FOR INCLINED ANCHOR PULL WITH 18 m I-BEAMS

179170-RD
Bart 7 disk

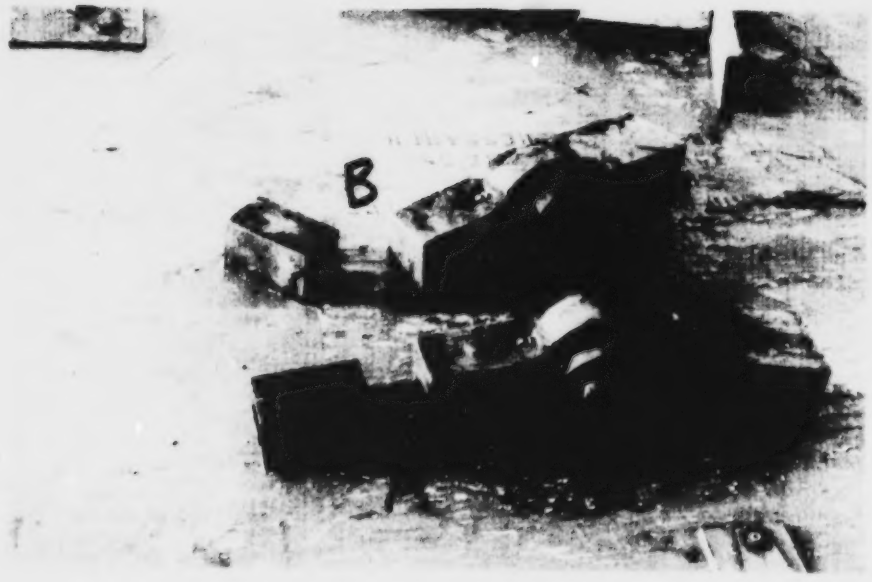


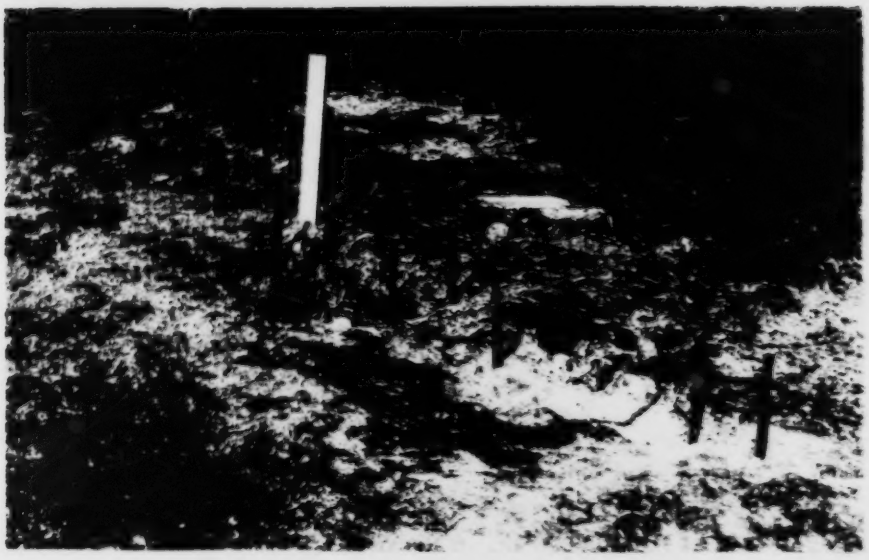
FIGURE 23a

SPECIAL ADAPTOR COUPLING "A" WAS USED TO ATTACH THE PULLING RODS TO THE PLATE ANCHOR (FOR FOOTING #4, THE SPECIAL ADAPTOR BROKE DURING TESTING "B")

FIGURE 23b

TWO 900 kN CAPACITY, HOLLOW RAM HYDRAULIC JACKS SET AT AN INCLINE TO THE I-BEAMS APPLIED THE LOAD (PULL ANGLE WAS 34° TO 40° TO HORIZONTAL)

179169-RD
Bart 7 disk



Vertical Telltales Installed for Anchor #1

Vertical and Inclined Telltales Installed for Anchor #2

FIGURE 24

TYPICAL LAYOUT OF TELLTALES IN PVC ACCESS TUBES TO MONITOR SOIL MOVEMENTS DURING PULLOUT TESTS

179168-RD
Bart 7 disk

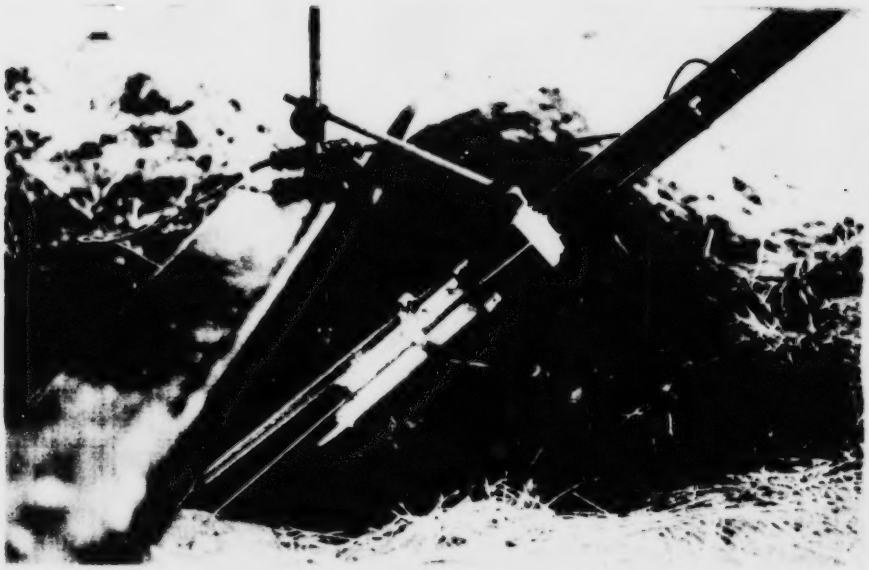
FIGURE 25a

TYPICAL DISPLACEMENT POTENTIOMETER USED TO MEASURE MOVEMENTS IN TELLTALE RODS AND PULLING ROD

FIGURE 25b

MOUNTING THE DISPLACEMENT POTENTIOMETER ONTO THE BATTER BOARDS PRIOR TO TESTING

179167-RD
Bart 7 disk



Displacement Potentiometer to Measure the Uplift Anchor

Telltales and Potentiometer for Ground Heave Measurements

FIGURE 26

TYPICAL SET-UP OF DISPLACEMENT POTENTIOMETER AND TELLTALES TO MEASURE THE ANCHOR AND SOIL MOVEMENTS

179166-RD
Bart 7 disk

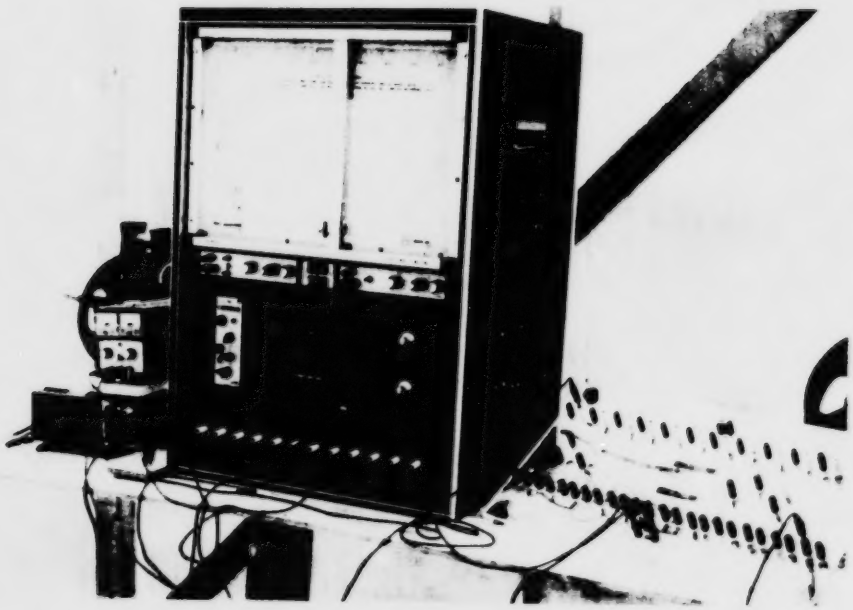


FIGURE 27

X-Y PLOTTER WAS USED TO PROVIDE REAL-TIME LOAD-DISPLACEMENT CURVE OF THE TEST ANCHOR

179165-RD
Bart 7 disk

FIGURE 28 FULL–SCALE LOAD TESTING OF INCLINED PLATE ANCHORS NO. 1 AND 2 EMBEDDED IN BACKFILL MATERIAL

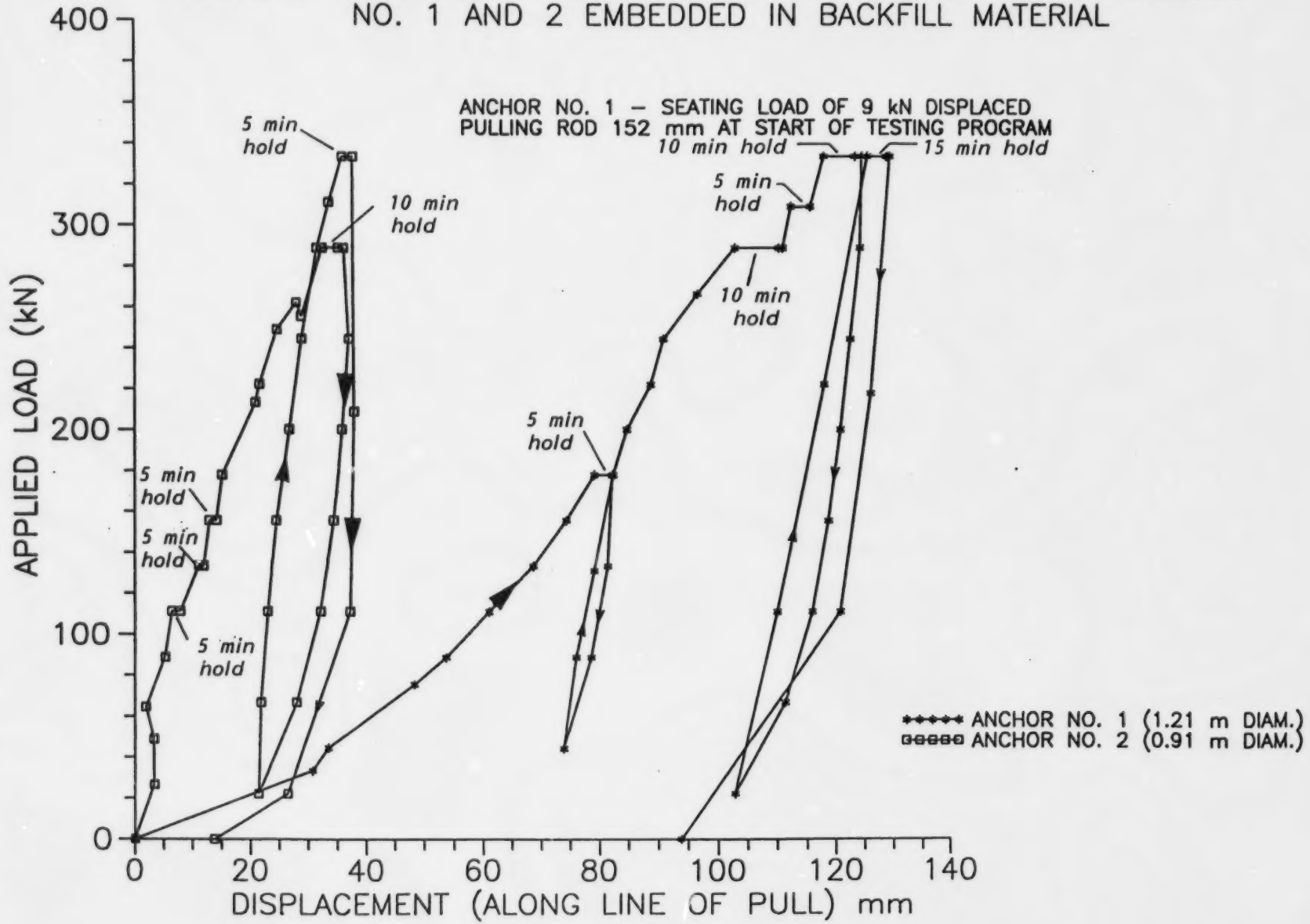
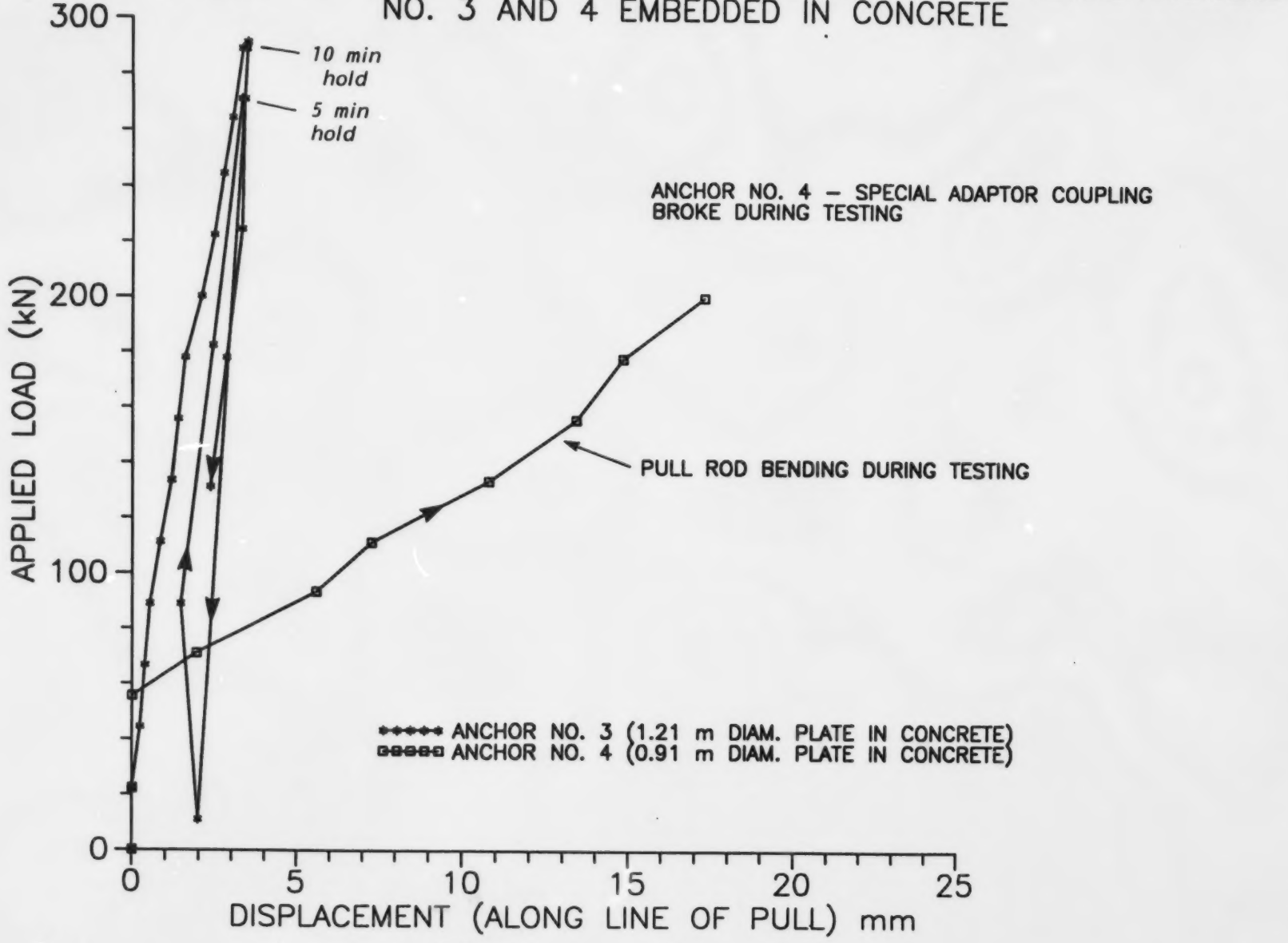
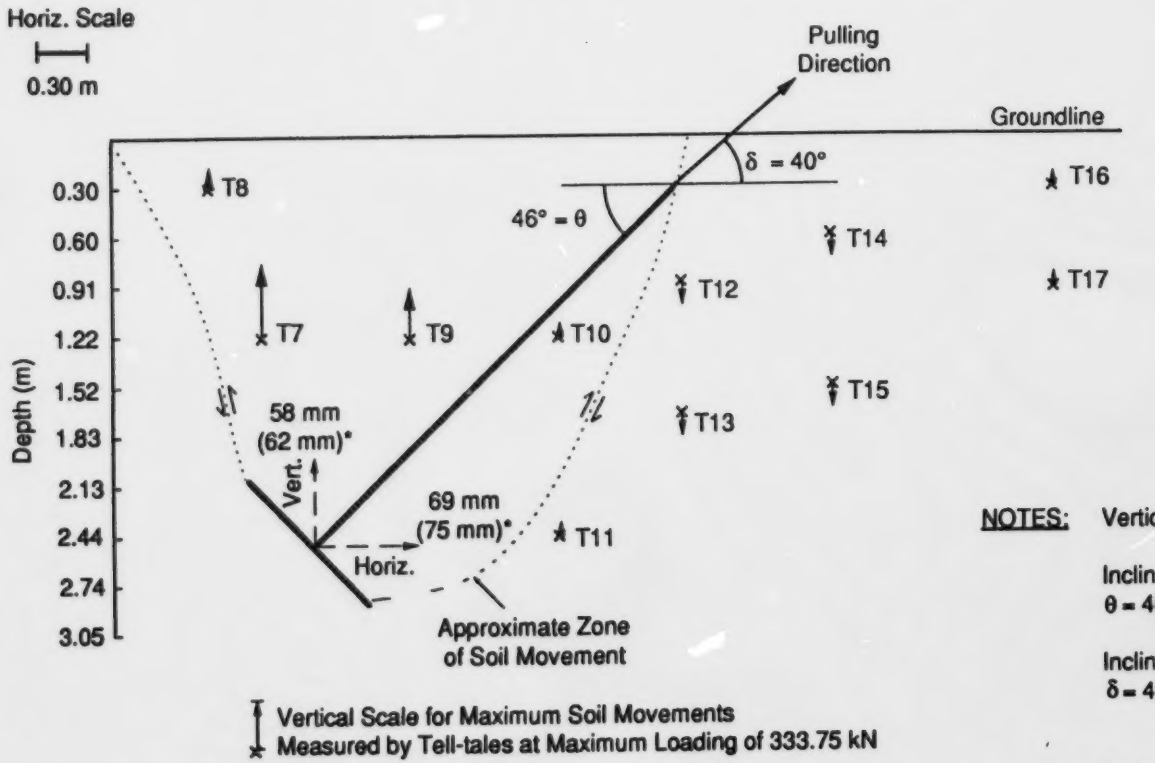


FIGURE 29 FULL–SCALE LOAD TESTING OF INCLINED PLATE ANCHORS NO. 3 AND 4 EMBEDDED IN CONCRETE





NOTES: Vertical Tell-tales No. T7 to T17

Inclination of Plate Anchor After Installation, $\theta = 46°$ with Respect to Horizontal

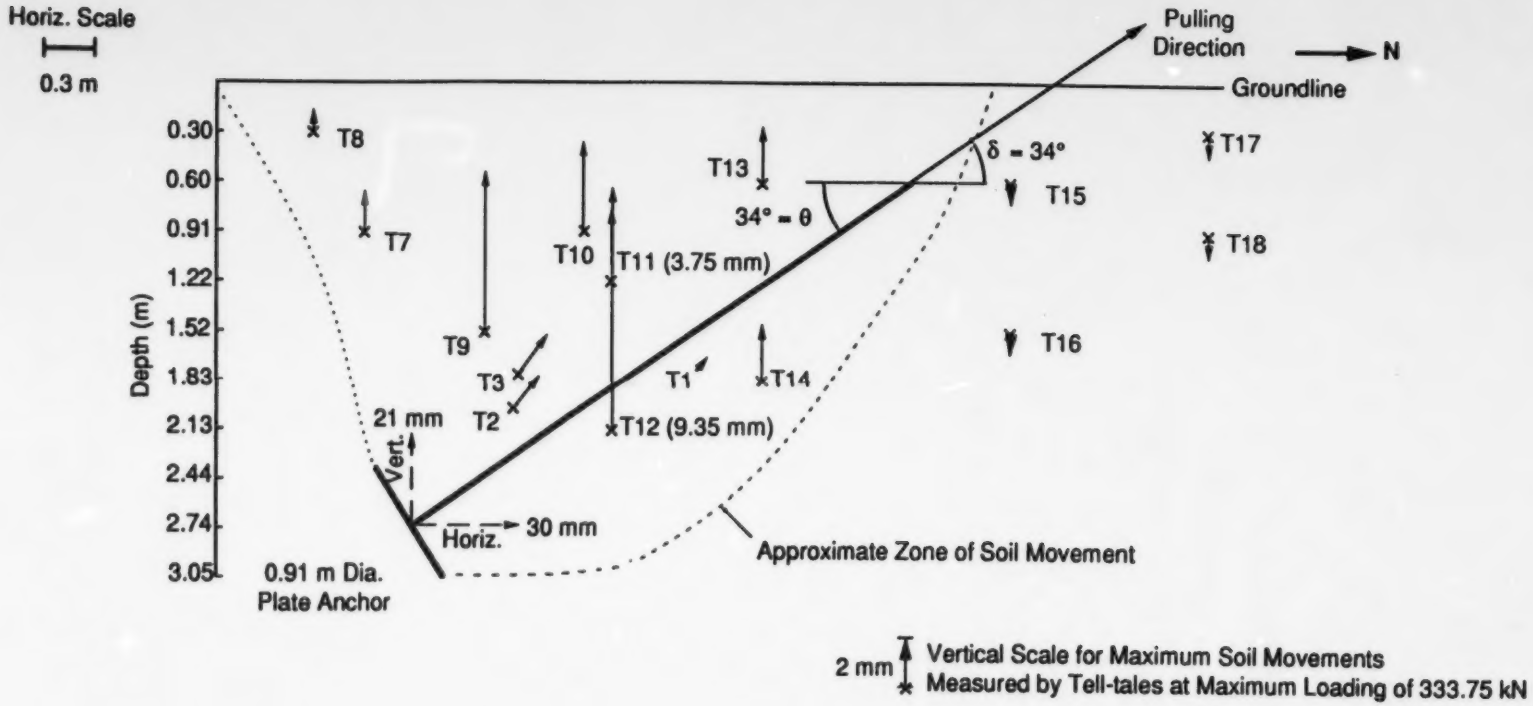
Inclination of Pulling Rod During Load Testing, $\delta = 40°$ with Respect to Horizontal

* *Plate Anchor Displacement During Second Loading Cycle - Tell-tales No. T7 To T17 Indicated Similar Maximum Soil Movements as Initial Loading.*

FIGURE 30

SOIL MOVEMENTS INDICATED BY TELL-TALES IN ANCHOR #1 AT MAXIMUM LOAD LEVELS

179232-S12-RD



NOTES: Vertical Tell-tales No. T7 to T18

Inclined Tell-tales No. T1 at 51°
Inclined Tell-tales No. T2 at 50°
Inclined Tell-tales No. T3 at 53°

Inclination of Plate Anchor After Installation,
$\theta = 34°$ with Respect to Horizontal

Inclination of Pulling Rod During Load Testing,
$\delta = 34°$ with Respect to Horizontal

FIGURE 31

SOIL MOVEMENTS INDICATED BY TELL-TALES IN ANCHOR #2 AT MAXIMUM LOAD LEVELS

APPENDIX A

SOIL INVESTIGATION

PROJECT ESSA TS - ANCHOR #1 | HOLE TYPE FLIGHT ANCHOR | OBSERVER

LOCATION HOLE #1A - NATIVE SOIL | HOLE SIZE | COMPILED

DIP | DRILLED OCTOBER 31/88 | CHECKED

DATUM | BEARING | DRAWN NOVEMBER 21/88 | APPROVED

BORING DATA						BORING LOG	WATER INF.		FIELD TESTS		LABORATORY TESTS					
SCALE - METRES	ELEV / DEPTH	(1) SAMPLE NO	(2) SAMPLE TYPE	(3) 'N' VALUE per 0.3m / RQD - %	(4) WATER LEVEL and CAVING / W.R.	(5) DESCRIPTION	(6) REMARKS	(7) OBSERVATION WELL DATA	(8) 'k' soil/rock cm/s / WATER PRESS. TEST	(9) SPECIAL TESTS TYPE	(9) SPECIAL TESTS RESULTS	NATURAL DENSITY * kg/m³	MOISTURE CONTENT - %	(10) SHEAR STRENGTH kPa TYPE	(10) SHEAR STRENGTH kPa RESULTS	(11) SPECIAL TESTS TYPE	(11) SPECIAL TESTS RESULTS
1		1		6		LOOSE TO VERY DENSE, MOIST, BROWN FINE SANDY SILT						1981	12.4				
		2		49									8.6				
		3		68								1958	3.9				
2						AUGERED TO 2.25 m COBBLES PRESENT						1881	3.8				
		4		27		COARSE GRAVEL							5.8				
		5		32								1740	NA				
3						DENSE AND COMPACT, MOIST, LIGHT BROWN, FINE SANDY SILT							11				
		6		26								1638	3.4				
		7		17									4.3				
4													3.8				
		8		25									4.2				
		9		23									3.8				
5													10.9				
		10		29									18.7				
		11		45									8.3				
6																	
7																	
8																	

* SHELBY TUBE DENSITY FROM HOLE #1B

GEOTECHNICAL DATA SHEET

hole no 1A | Fig A1

sheet 1 OF 1

200984-RD

PROJECT ESSA TS - ANCHOR #1 HOLE TYPE FLIGHT AUGER OBSERVER

LOCATION HOLE #1C - BACKFILL HOLE SIZE COMPILED

DIP DRILLED OCTOBER 31/88 CHECKED

DATUM BEARING DRAWN NOVEMBER 21/88 APPROVED

BORING DATA						BORING LOG		WATER INF.		FIELD TESTS		LABORATORY TESTS					
SCALE - METRES	ELEV / DEPTH	(1) SAMPLE NO	(2) SAMPLE TYPE	(3) 'N' VALUE per 0.3m / ROD - %	(4) WATER LEVEL and CAVING / W.R.	(5) DESCRIPTION	(6) REMARKS	(7) OBSERVATION WELL DATA	(8) 'k' soil/rock cm/s / WATER PRESS. TEST	(9) SPECIAL TESTS TYPE	(9) SPECIAL TESTS RESULTS	* NATURAL DENSITY kg/m³	MOISTURE CONTENT - %	(10) SHEAR STRENGTH kPa TYPE	(10) SHEAR STRENGTH kPa RESULTS	(11) SPECIAL TESTS TYPE	(11) SPECIAL TESTS RESULTS
1		1		18		COMPACT, MOIST, BROWN FINE SANDY SILT						1633	5.8 / 6.6				
		2		20								1711	6.2 / 7.0				
		3		23								1600	8.2 / 6.4				
2		4		11								1605	7.9 / 7.3				
		5		21		COMPACT, MOIST, BROWN FINE SAND WITH SOME SILT, SOME MEDIUM TO COARSE GRAVEL, LITTLE MEDIUM SAND AND LITTLE ORGANICS						1762	6.3 / 8.3				
		6		22								1597	7.6 / 5.3				
3		7		17		COMPACT TO DENSE, BROWN, MOIST FINE SANDY SILT						1520	5.3 / 5.2				
		8		35									4.8				
4																	
5																	
6																	
7																	

dwg no

* SHELBY TUBE DENSITY FROM HOLE #1D

GEOTECHNICAL DATA SHEET

hole no 1C

sheet 1 OF 1

Fig A2

200985-RD

PROJECT ESSA TS - ANCHOR #2 — HOLE TYPE — OBSERVER

LOCATION HOLE #2A - NATIVE SOIL — HOLE SIZE FLIGHT AUGER — COMPILED

DIP — DRILLED NOVEMBER 1/88 — CHECKED

DATUM — BEARING — DRAWN NOVEMBER 18/88 — APPROVED

BORING DATA						BORING LOG	WATER INF.		FIELD TESTS		LABORATORY TESTS					
SCALE - METRES	ELEV / DEPTH	(1) SAMPLE NO	(2) SAMPLE TYPE	(3) 'N' VALUE per 0.3m / ROD - %	(4) WATER LEVEL and CAVING W.L.	(5) DESCRIPTION	(6) REMARKS	(7) OBSERVATION WELL DATA	(8) 'k' soil/rock cm/s / WATER PRESS. TEST	(9) SPECIAL TESTS TYPE	(9) SPECIAL TESTS RESULTS	NATURAL DENSITY kg/m³	MOISTURE CONTENT - %	(10) SHEAR STRENGTH kPa TYPE	(10) SHEAR STRENGTH kPa RESULTS	(11) SPECIAL TESTS TYPE	(11) SPECIAL TESTS RESULTS
1		1		12		COMPACT TO VERY DENSE, MOIST, LIGHT BROWN, FINE SANDY SILT											
		2		12								1649	6.2 / 8.3				
		3		25								1646	N.A / 5.5				
2		4		35								1792	8.1 / 11.8				
		5		44								1680	5.9 / 4.0				
		6		35								1631	4.4 / 7.1				
3		7		43								1580	4.4 / 6.3				
		8		32									3.8				
		9		45									9.4				
4		10		33									9.4				
		11		25									16.6				
		12		38									5.8				
5		13		58									18.0				
													10.4				
6																	
7																	
8																	

Da Bap

* SHELBY TUBE DENSITY FROM HOLE #2B

GEOTECHNICAL DATA SHEET

hole no 2A — Fig A3

sheet 1 OF 1

200986-RD

PROJECT ESSA TS - ANCHOR #2 | HOLE TYPE FLIGHT AUGER | OBSERVER

LOCATION HOLE #2D - BACKFILL | HOLE SIZE | COMPILED

DIP | DRILLED NOVEMBER 1/88 | CHECKED

DATUM | BEARING | DRAWN NOVEMBER 21/88 | APPROVED

BORING DATA					BORING LOG	WATER INF.		FIELD TESTS		LABORATORY TESTS				
SCALE-METRES	ELEV / DEPTH	(1) SAMPLE NO	(2) SAMPLE TYPE	(3) 'N' VALUE per 0.3m / ROD-%	(4) WATER LEVEL and CAVING / W.R.	(5) DESCRIPTION	(6) REMARKS	(7) OBSERVATION WELL DATA	(8) 'k' cm/s / WATER PRESS. TEST	(9) SPECIAL TESTS TYPE	(9) SPECIAL TESTS RESULTS	NATURAL DENSITY kg/m³ *	MOISTURE CONTENT - %	(10) SHEAR STRENGTH kPa TYPE	(10) SHEAR STRENGTH kPa RESULTS	(11) SPECIAL TESTS TYPE	(11) SPECIAL TESTS RESULTS
1		1	SS	21		COMPACT, DARK AND LIGHT BROWN, MOIST FINE SAND WITH SOME SILT											
		2	SS	24								1360	8.4 / 11.3				
		3	SS	30		COMPACT TO DENSE, BROWN, MOIST FINE SAND, SOME SILT, SOME CLUMPS OF CLAY SILT						1736	4.1 / 9.4				
2		4	SS	21								—	8.8 / 9.2				
		5	SS	51		COMPACT TO DENSE, LIGHT BROWN, MOIST FINE SANDY SILT						1791	5.0 / 10.0				
		6	SS	21								1620	5.3 / 4.8				
3		7	SS	34								1646	5.7 / 5.1				
		8	SS	39									3.8				
4													11.2				
5																	
6																	
7																	
8																	
9																	

2 Sep

* SHELBY TUBE DENSITY FROM HOLE #2C

GEOTECHNICAL DATA SHEET

hole no 2D | Fig A4

sheet 1 OF 1

200587-RD

PROJECT ESSA TS - ANCHOR #3 | HOLE TYPE FLIGHT AUGER | OBSERVER

LOCATION HOLE #3C - NATIVE SOIL | HOLE SIZE | COMPILED

DIP | DRILLED NOVEMBER 1/88 | CHECKED

DATUM | BEARING | DRAWN NOVEMBER 21/88 | APPROVED

BORING DATA						BORING LOG	WATER INF.		FIELD TESTS		LABORATORY TESTS					
SCALE - METRES	ELEV / DEPTH	(1) SAMPLE NO	(2) SAMPLE TYPE	(3) 'N' VALUE per 0.3m / RQD - %	(4) WATER LEVEL and CAVING / W.R.	(5) DESCRIPTION	(6) REMARKS	(7) OBSERVATION WELL DATA	(8) 'k' soil/rock cm/s / WATER PRESS. TEST	(9) SPECIAL TESTS TYPE	(9) SPECIAL TESTS RESULTS	NATURAL DENSITY kg/m³	MOISTURE CONTENT - %	(10) SHEAR STRENGTH kPa TYPE	(10) SHEAR STRENGTH kPa RESULTS	(11) SPECIAL TESTS TYPE	(11) SPECIAL TESTS RESULTS
1		1		3		VERY LOOSE, BROWN, MOIST, SILTY FINE SAND							10.5				
		2		19									16.5				
		3		30		HARD MOIST GREYISH BROWN SILTY CLAY							16.5				
2		4		60									13.2				
		5		58		VERY DENSE, MOIST, BROWN FINE SANDY SILT WITH SOME CLAY							4.2				
		6		58		VERY DENSE, MOIST, BROWN FINE SANDY SILT							7.7				
3		7		38									6.4				
		8		56		DENSE AND VERY DENSE, MOIST, LIGHT BROWN, FINE SANDY SILT							4.3				
4		9		45									17.1				
		10		37									10.2				
5		11		43									8.0				
		12		51									15.8				
		13		61									6.5				
6																	
7																	
8																	
9																	
10																	

GEOTECHNICAL DATA SHEET

hole no 3C | Fig A5

sheet 1 OF 1

200988-RD

PROJECT ESSA TS - ANCHOR #3 | HOLE TYPE FLIGHT AUGER | OBSERVER

LOCATION HOLE #3B - BACKFILL | HOLE SIZE | COMPILED

DIP | DRILLED NOVEMBER 1/88 | CHECKED

DATUM | BEARING | DRAWN NOVEMBER 21/88 | APPROVED

BORING DATA						BORING LOG	WATER INF.		FIELD TESTS		LABORATORY TESTS					
SCALE - METRES	ELEV / DEPTH	(1) SAMPLE NO	(2) SAMPLE TYPE	(3) 'N' VALUE per 0.3m / ROD-%	(4) WATER LEVEL and CAVING / W.R.	(5) DESCRIPTION / (6) REMARKS	(7) OBSERVATION WELL DATA	(8) 'k' cm/s / WATER PRESS. TEST	(9) SPECIAL TESTS TYPE	(9) SPECIAL TESTS RESULTS	NATURAL DENSITY kg/m³ *	MOISTURE CONTENT - %	(10) SHEAR STRENGTH kPa TYPE	(10) SHEAR STRENGTH kPa RESULTS	(11) SPECIAL TESTS TYPE	(11) SPECIAL TESTS RESULTS
1		1		8		SOFT MOIST BROWN CLAYEY SILT WITH SOME FINE SAND, SOME ORGANICS					1947	21.2 / 20.5				
		2		7		LOOSE, MOIST, BROWN, FINE SANDY SILT WITH LITTLE CLAY					1985	17.0 / 19.0				
		3		6							1604	17.2 / 18.2				
2		4		13		COMPACT TO DENSE, MOIST, LIGHT BROWN FINE SANDY SILT					1746	6.2 / 17.4				
		5		25							1682	4.7 / 6.2				
		6		36							1666	3.6 / 4.2				
3											1585	— / 7.8				
4																
5																
6																

* SHELBY TUBE DENSITY FROM HOLE #3A

GEOTECHNICAL DATA SHEET

hole no 3B | Fig A6

sheet 1 OF 1

200989-RD

PROJECT ESSA TS - ANCHOR #4 | HOLE TYPE FLIGHT AUGER | OBSERVER

LOCATION HOLE #4A - NATIVE SOIL | HOLE SIZE | COMPILED

DIP | DRILLED NOVEMBER 1/88 | CHECKED

DATUM | BEARING | DRAWN NOVEMBER 21/88 | APPROVED

BORING DATA						BORING LOG		WATER INF.		FIELD TESTS		LABORATORY TESTS				
SCALE - METRES	ELEV / DEPTH	(1) SAMPLE NO	(2) SAMPLE TYPE	(3) 'N' VALUE per 0.3m / ROD - %	(4) WATER LEVEL and CAVING / W.R.	(5) DESCRIPTION	(6) REMARKS	(7) OBSERVATION WELL DATA	(8) 'k' cm/s / WATER PRESS. TEST	(9) SPECIAL TESTS TYPE	(9) SPECIAL TESTS RESULTS	NATURAL DENSITY kg/m³	MOISTURE CONTENT - %	(10) SHEAR STRENGTH kPa TYPE	(10) SHEAR STRENGTH kPa RESULTS	(11) SPECIAL TESTS TYPE	(11) SPECIAL TESTS RESULTS
0		1		4		VERY LOOSE, MOIST, BROWN, FINE SANDY SILT, TRACE OF ORGANICS							10.6				
1		2		5		VERY LOOSE, MOIST, BROWN CLAYEY FINE SANDY SILT, LITTLE MEDIUM TO COARSE SAND							16.7				
		3		17		COMPACT, MOIST, GREYISH BROWN SILT SOME CLAY, SOME FINE SAND							16.2				
2		4		36		DENSE, MOIST, LIGHT BROWN FINE SANDY SILT							4.2				
		5		51		VERY DENSE, MOIST, LIGHT BROWN FINE SANDY SILT							4.6				
3		6		57									3.4				
		7		61									7.1				
4		8		52									4.6				
		9		51									8.6				
		10		44		DENSE, MOIST, LIGHT BROWN FINE SANDY SILT							11.4				
5		11		40									5.6				
		12		38									17.8				
6		13		44									10.3				
7																	
8																	
9																	
10																	
11																	

2 Sep

GEOTECHNICAL DATA SHEET

hole no 4A | Fig A7

sheet 1 OF 1

200990-RD

PROJECT ESSA TS - ANCHOR #8 | HOLE TYPE FLIGHT AUGER | OBSERVER

LOCATION HOLE #8B - BACKFILL | HOLE SIZE | COMPILED

DIP | DRILLED NOVEMBER 1/88 | CHECKED

DATUM | BEARING | DRAWN NOVEMBER 21/88 | APPROVED

BORING DATA					BORING LOG	WATER INF.		FIELD TESTS		LABORATORY TESTS					
SCALE - METRES	ELEV / DEPTH	(1) SAMPLE NO	(2) SAMPLE TYPE	(3) 'N' VALUE per 0.3m / ROD - %	(4) WATER LEVEL and CAVING / W.R.	(5) DESCRIPTION	(6) REMARKS	(7) OBSERVATION WELL DATA	(8) 'K' cm/s / WATER PRESS. TEST	(9) SPECIAL TESTS TYPE	(9) SPECIAL TESTS RESULTS	NATURAL* DENSITY kg/m³	MOISTURE CONTENT - %	(10) SHEAR STRENGTH kPa TYPE	(10) SHEAR STRENGTH kPa RESULTS	(11) SPECIAL TESTS TYPE	(11) SPECIAL TESTS RESULTS
0		1		3		VERY LOOSE, MOIST, BROWN, FINE SANDY SILT						1614	9.7 / 17.1				
1		2		17		HARD, MOIST, GREY, CLAY SILT WITH SOME FINE SAND, LITTLE MEDIUM TO COARSE SAND, LITTLE FINE GRAVEL						1761	14.7 / 9.3				
		3		22								1788	16.7 / 12.0				
2		4		32		DENSE TO VERY DENSE, MOIST, LIGHT BROWN FINE SANDY SILT							10.4				
		5		37									8.7				
3		6		51									8.2				

* SHELBY TUBE DENSITY FROM HOLE #8C

GEOTECHNICAL DATA SHEET

hole no 8B | Fig A8

sheet 1 OF 1

200991-RD

PROJECT ESSA TS — HOLE TYPE FLIGHT AUGER — OBSERVER

LOCATION TEST PIT - BACKFILL TAMPED W/ BUCKET — HOLE SIZE — COMPILED

DIP — DRILLED NOVEMBER 4/88 — CHECKED

DATUM — BEARING — DRAWN NOVEMBER 21/88 — APPROVED

BORING DATA						BORING LOG		WATER INF.		FIELD TESTS		LABORATORY TESTS				
SCALE - METRES	ELEV / DEPTH	(1) SAMPLE NO	(2) SAMPLE TYPE	(3) 'N' VALUE per 0.3m / ROD - %	(4) WATER LEVEL and DATE / W.R.	(5) DESCRIPTION	(6) REMARKS	(7) OBSERVATION WELL DATA	(8) 'k' cm/s / WATER PRESS. TEST	(9) SPECIAL TESTS TYPE	(9) SPECIAL TESTS RESULTS	NATURAL DENSITY kg/m³	MOISTURE CONTENT - %	(10) SHEAR STRENGTH kPa TYPE	(10) SHEAR STRENGTH kPa RESULTS	(11) SPECIAL TESTS TYPE	(11) SPECIAL TESTS RESULTS
1		1		4		VERY LOOSE, MOIST, GREY FINE SANDY SILT WITH SOME CLAY						13.5					
		2		5		LOOSE, MOIST, GREY FINE SANDY SILT WITH SOME CLAY AND A TRACE OF MEDIUM GRAVEL						11.6					
		3		7													
		4		6		LOOSE, MOIST, BROWN FINE SANDY SILT, LITTLE FINE TO MEDIUM GRAVEL, AND LITTLE ORGANIC MATERIAL						9.7					
2		5		6								14.7					
		6		5		LOOSE, MOIST, BROWN FINE SANDY SILT, LITTLE FINE TO MEDIUM GRAVEL AND SOME LUMPS OF CLAY SILT						13.4					
		7		28		LOOSE, MOIST, LIGHT BROWN FINE SANDY SILT, A TRACE OF MEDIUM GRAVEL						8.4					
3		8		39		COMPACT TO DENSE, LIGHT BROWN FINE SANDY SILT, MOIST						4.0					
												12.0					
4																	
5																	
6																	
7																	
8																	
9																	

GEOTECHNICAL DATA SHEET

hole no TEST PIT — Fig A9

sheet 1 OF 1

209992-RD

TABLE A10

ONTARIO HYDRO CIVIL RESEARCH TEST NO. D-1EBAC.DIL
FILE NAME: ESSA T5 - INCLINED PLATE ANCHOR TESTING
FILE NUMBER: 43-273

RECORD OF DILATOMETER TEST NO. D-1EBAC.DIL
USING DATA REDUCTION PROCEDURES IN MARCHETTI (ASCE,J-GED,MARCH 80)
KO IN SANDS DETERMINED USING SCHMERTMANN METHOD (1983)
PHI ANGLE CALCULATION BASED ON DURGUNOGLU AND MITCHELL (ASCE,RALEIGH CONF,JUNE 75)
PHI ANGLE NORMALIZED TO 2.72 BARS USING BALIGH'S EXPRESSION (ASCE,J-GED,NOV 76)
MODIFIED MAYNE AND KULHAWY FORMULA USED FOR OCR IN SANDS (ASCE,J-GED,JUNE 82)

LOCATION: FOOTING NO.1 BACKFILL MATERIAL STATIC PUSH AS FAR AS POSSIBLE THEN DRIVEN
PERFORMED - DATE: 03 NOV 88
BY: M GRILLS WITH SAFETY SPT HAMMER WITH 18 INCH DROP HEIGHT

CALIBRATION INFORMATION:
DELTA A = .33 BARS DELTA B = .70 BARS GAGE 0 = .05 BARS GWT DEPTH=20.00 M
ROD DIA.= 3.70 CM FR.RED.DIA.= 4.80 CM ROD WT.= 6.60 KG/M DELTA/PHI= .50 BLADE T=13.70 MM

1 BAR = 1.019 KG/CM2 = 1.044 TSF = 14.51 PSI ANALYSIS USES H2O UNIT WEIGHT = 1.000 T/M3

Z (M)	THRUST (KG)	A (BAR)	B (BAR)	ED (BAR)	ID	KD	U0 (BAR)	SAMMA (T/M3)	SV (BAR)	PC (BAR)	OCR	KO	CU (BAR)	PHI (DEG)	M (BAR)	SOIL TYPE
.30	101.	1.95	9.10	223.	3.34	40.08	.000	1.633	.048	*****	*****	5.47		8.5	850.6	SAND
.61	101.	1.45	7.70	190.	3.73	15.04	.000	1.633	.098	9.75	99.6[illegible]	2.40		13.7	549.0	SAND
.91	203.	3.30	14.00	352.	3.28	21.08	.000	1.711	.147	46.88	*****	3.14		13.4	1129.5	SILTY SAND
1.22	1400.	1.60	12.80	371.	7.79	6.89	.000	1.711	.199	.80	4.00	.72		42.3	806.6	SAND
1.52	1100.	.59	4.05	89.	3.41	3.02	.000	1.600	.248	.19	.75	.31		41.6	129.3	SAND
1.83	1200.	1.55	7.30	172.	3.11	5.38	.000	1.605	.296	1.04	3.50	.70		39.3	337.3	SILTY SAND
2.13	500.	.30	2.55	44.	2.47	1.51	.000	1.605	.344	.30	.86	.39		34.3	37.8	SILTY SAND
2.44	600.	.20	1.90	24.	1.58	1.13	.000	1.762	.395	.24	.61	.33		35.3	20.7	SANDY SILT
2.74	600.	.00	.00	-36.	-3.68		.000	P01 =	.33	P0 =	.28	P1 =	-.75			QUESTIONABLE
2.90	500.	.30	3.30	72.	4.30	1.02	.000	1.597	.471	.34	.73	.38		32.7	61.0	SAND
3.05	900.	1.75	7.90	187.	3.03	3.59	.000	1.597	.494	1.24	2.52	.65		34.7	300.3	SILTY SAND
3.35	2900.	7.40	32.00	859.	3.81	12.04	.000	1.520	.540	9.18	17.01	1.55		38.8	2297.7	SAND
3.51	3500.	6.30	26.00	680.	3.47	10.01	.000	1.520	.564	6.18	10.95	1.24		40.9	1701.4	SAND

END OF SOUNDING

THRUST AND UNIT WEIGHT MEASURED

TABLE A11

ONTARIO HYDRO CIVIL RESEARCH — TEST NO. D-16BAC.DIL
FILE NAME: ESSA T5 - INCLINED PLATE ANCHOR TESTING
FILE NUMBER: 43-273

RECORD OF DILATOMETER TEST NO. D-16BAC.DIL
USING DATA REDUCTION PROCEDURES IN MARCHETTI (ASCE,J-GED,MARCH 80)
KO IN SANDS DETERMINED USING SCHMERTMANN METHOD (1983)
PHI ANGLE CALCULATION BASED ON DURGUNOGLU AND MITCHELL (ASCE,RALEIGH CONF,JUNE 75)
PHI ANGLE NORMALIZED TO 2.72 BARS USING BALIGH'S EXPRESSION (ASCE,J-GED,NOV 76)
MODIFIED MAYNE AND KULHAWY FORMULA USED FOR OCR IN SANDS (ASCE,J-GED,JUNE 82)

LOCATION: FOOTING NO.1 BACKFILL MATERIAL STATIC PUSH AS FAR AS POSSIBLE THEN DRIVEN
PERFORMED - DATE: 03 NOV 88
BY: M GRILLS WITH SAFETY SPT HAMMER WITH 18 INCH DROP HEIGHT

CALIBRATION INFORMATION:
DELTA A = .34 BARS DELTA B = .88 BARS GAGE 0 = .05 BARS GWT DEPTH=20.00 M
ROD DIA.= 3.70 CM FR.RED.DIA.= 4.80 CM ROD WT.= 5.60 KG/M DELTA/PHI= .50 BLADE T=13.70 MM

1 BAR = 1.019 KG/CM2 = 1.044 TSF = 14.51 PSI ANALYSIS USES H2O UNIT WEIGHT = 1.000 T/M3

Z (M)	THRUST (KG)	A (BAR)	B (BAR)	ED (BAR)	ID	KD	UO (BAR)	GAMMA (T/M3)	SV (BAR)	PC (BAR)	OCR	KO	CU (BAR)	PHI (DEG)	M (BAR)	SOIL TYPE
.30	128.	1.35	8.60	220.	4.73	27.89	.000	1.633	.048	10.23	*****	3.81		18.7	762.6	SAND
.61	1000.	2.45	11.70	293.	3.61	23.94	.000	1.633	.098	5.83	59.71	2.91		38.3	973.2	SAND
.91	1200.	2.00	14.10	396.	6.54	11.89	.000	1.711	.147	2.03	13.83	1.38		40.8	1055.9	SAND
1.22	1400.	2.20	14.70	411.	6.15	9.68	.000	1.711	.199	1.87	9.39	1.13		40.8	1015.9	SAND
1.52	1600.	2.85	17.30	482.	5.60	10.01	.000	1.600	.248	2.63	10.62	1.21		40.2	1205.4	SAND
1.83	1700.	3.30	21.80	630.	6.66	9.20	.000	1.605	.296	2.76	9.32	1.14		39.8	1528.1	SAND
2.13	2100.	.90	3.90	65.	1.70	3.20	.000	1.605	.344	.09	.26	.16		44.6	91.7	SANDY SILT
2.44	1200.	1.95	13.50	376.	6.29	4.36	.000	1.762	.395	1.08	2.75	.64		38.0	669.9	SAND
2.74	1400.	2.10	12.50	334.	4.99	4.32	.000	1.762	.447	1.19	2.65	.63		38.5	592.5	SAND
3.05	1300.	2.35	15.00	416.	5.80	4.15	.000	1.597	.498	1.36	2.73	.65		37.3	723.4	SAND
3.35	2200.	5.80	27.20	735.	4.17	9.34	.000	1.520	.544	5.98	10.99	1.26		37.8	1794.8	SAND
3.65	3800.	6.65	32.00	879.	4.42	9.74	.000	1.520	.589	5.98	10.16	1.19		41.3	2178.0	SAND

END OF SOUNDING

THRUST AND UNIT WEIGHT MEASURED

TABLE A12

ONTARIO HYDRO CIVIL RESEARCH TEST NO. D-2NAT.DIL
FILE NAME: ESSA TS - INCLINED PLATE ANCHOR TESTING
FILE NUMBER: 43-273

RECORD OF DILATOMETER TEST NO. D-2NAT.DIL
USING DATA REDUCTION PROCEDURES IN MARCHETTI (ASCE,J-GED,MARCH 80)
KO IN SANDS DETERMINED USING SCHMERTMANN METHOD (1983)
PHI ANGLE CALCULATION BASED ON DURGUNOGLU AND MITCHELL (ASCE,RALEIGH CONF,JUNE 75)
PHI ANGLE NORMALIZED TO 2.72 BARS USING BALIGH'S EXPRESSION (ASCE,J-GED,NOV 76)
MODIFIED MAYNE AND KULHAWY FORMULA USED FOR OCR IN SANDS (ASCE,J-GED,JUNE 82)

LOCATION: FOOTING NO.2 NATIVE MATERIAL STATIC PUSH AS FAR AS POSSIBLE THEN DRIVEN
PERFORMED - DATE: 04 NOV 88
BY: M GRILLS WITH SAFETY SPT HAMMER WITH 18 INCH DROP HEIGHT

CALIBRATION INFORMATION:
DELTA A = .35 BARS DELTA B = 1.15 BARS GAGE 0 = .05 BARS GWT DEPTH=20.00 M
ROD DIA.= 3.70 CM FR.RED.DIA.= 4.80 CM ROD WT.= 6.60 KG/M DELTA/PHI= .50 BLADE T=13.70 MM

1 BAR = 1.019 KG/CM2 = 1.044 TSF = 14.51 PSI ANALYSIS USES H2O UNIT WEIGHT = 1.000 T/M3

Z (M)	THRUST (KG)	A (BAR)	B (BAR)	ED (BAR)	ID	KD	UO (BAR)	GAMMA (T/M3)	SV (BAR)	PC (BAR)	OCR	KO	CU (BAR)	PHI (DEG)	M (BAR)	SOIL TYPE
.30	500.	.45	3.80	67.	2.95	13.42	.000	1.649	.049						187.3	SILTY SAND
.61	600.	1.15	4.40	64.	1.35	13.74	.000	1.649	.099	2.08	21.01	1.72		37.2	178.6	SANDY SILT
.91	600.	.50	3.05	38.	1.47	5.06	.000	1.649	.148	.44	2.98	.64		38.8	70.4	SANDY SILT
1.22	1000.	4.15	12.90	264.	1.86	20.66	.000	1.646	.198	10.89	55.06	2.69		33.3	841.9	SILTY SAND
1.52	1800.	4.35	20.50	534.	3.93	15.77	.000	1.792	.248	6.81	27.40	1.96		38.7	1564.6	SAND
1.83	2800.	7.20	35.20	966.	4.51	20.38	.000	1.792	.303	13.52	44.63	2.50		39.4	3064.8	SAND
2.13	3800.	8.55	30.40	741.	2.73	22.12	.000	1.680	.354	18.14	51.25	2.69		40.3	2411.0	SILTY SAND
2.44	4500.	9.10	40.40	1086.	3.96	19.56	.000	1.631	.404	15.71	38.84	2.34		41.4	3404.0	SAND
2.74	3700.	8.45	38.10	1026.	4.03	16.26	.000	1.580	.452	12.84	28.43	2.00		40.3	3035.9	SAND
3.05	4000.	8.60	39.80	1082.	4.21	14.84	.000	1.580	.500	11.76	23.52	1.82		40.7	3109.5	SAND

END OF SOUNDING

THRUST AND UNIT WEIGHT MEASURED

TABLE A13

ONTARIO HYDRO CIVIL RESEARCH — TEST NO. D-2EBAC.DIL
FILE NAME: ESSA T5 - INCLINED PLATE ANCHOR TESTING
FILE NUMBER: 43-273

RECORD OF DILATOMETER TEST NO. D-2EBAC.DIL
USING DATA REDUCTION PROCEDURES IN MARCHETTI (ASCE,J-GED,MARCH 80)
KO IN SANDS DETERMINED USING SCHMERTMANN METHOD (1983)
PHI ANGLE CALCULATION BASED ON DURGUNOGLU AND MITCHELL (ASCE,RALEIGH CONF,JUNE 75)
PHI ANGLE NORMALIZED TO 2.72 BARS USING BALIGH'S EXPRESSION (ASCE,J-GED,NOV 76)
MODIFIED MAYNE AND KULHAWY FORMULA USED FOR OCR IN SANDS (ASCE,J-GED,JUNE 82)

LOCATION: FOOTING NO.2 BACKFILL MATERIAL STATIC PUSH AS FAR AS POSSIBLE THEN DRIVEN
PERFORMED - DATE: 04 NOV 88
BY: M GRILLS WITH SAFETY SPT HAMMER WITH 18 INCH DROP HEIGHT

CALIBRATION INFORMATION:
DELTA A = .35 BARS DELTA B = 1.15 BARS GAGE 0 = .05 BARS GWT DEPTH=20.00 M
ROD DIA.= 3.70 CM FR.RED.DIA.= 4.80 CM ROD WT.= 6.60 KG/M DELTA/PHI= .50 BLADE T=13.70 MM

1 BAR = 1.019 KG/CM2 = 1.044 TSF = 14.51 PSI ANALYSIS USES H2O UNIT WEIGHT = 1.000 T/M3

Z (M)	THRUST (KG)	A (BAR)	B (BAR)	ED (BAR)	ID	KD	UO (BAR)	GAMMA (T/M3)	SV (BAR)	PC (BAR)	OCR	KO	CU (BAR)	PHI (DEG)	M (BAR)	SOIL TYPE
.30	115.	.40	4.15	82.	4.02	14.69	.000	1.360	.040	1.19	29.87	2.02		28.3	234.8	SAND
.61	180.	1.60	10.90	284.	5.42	18.56	.000	1.360	.081	5.50	67.55	2.64		22.3	876.8	SAND
.91	233.	2.10	14.80	408.	6.39	14.49	.000	1.736	.127	5.06	39.88	2.15		23.3	1163.6	SAND
1.22	1700.	2.85	17.80	490.	5.70	13.78	.000	1.736	.180	3.33	18.50	1.60		41.2	1374.0	SAND
1.52	2300.	3.70	15.60	379.	3.14	15.07	.000	1.736	.231	5.17	22.39	1.77		41.3	1094.5	SILTY SAND
1.83	3000.	6.60	34.80	973.	5.04	19.56	.000	1.791	.285	11.18	39.29	2.36		40.6	3049.9	SAND
2.13	2500.	4.50	24.00	656.	4.85	11.56	.000	1.791	.337	4.70	13.94	1.39		40.9	1729.8	SAND
2.44	1900.	2.80	13.00	317.	3.43	6.85	.000	1.620	.389	2.07	5.32	.86		40.2	688.2	SAND
2.74	900.	1.55	7.80	173.	3.09	3.69	.000	1.620	.437	1.09	2.49	.64		35.5	282.9	SILTY SAND
3.05	500.	.60	5.35	118.	4.63	1.52	.000	1.646	.487	.52	1.06	.46		31.9	102.0	SAND
3.20	600.	2.80	15.90	423.	4.83	4.93	.000	1.646	.511	2.52	4.92	.93		29.1	797.3	SAND

END OF SOUNDING

THRUST AND UNIT WEIGHT MEASURED

TABLE A14

ONTARIO HYDRO CIVIL RESEARCH — TEST NO. D-2FBAC.DIL
FILE NAME: ESSA TS - INCLINED PLATE ANCHOR TESTING
FILE NUMBER: 43-273

RECORD OF DILATOMETER TEST NO. D-2FBAC.DIL
USING DATA REDUCTION PROCEDURES IN MARCHETTI (ASCE,J-GED,MARCH 80)
KO IN SANDS DETERMINED USING SCHMERTMANN METHOD (1983)
PHI ANGLE CALCULATION BASED ON DURGUNOGLU AND MITCHELL (ASCE,RALEIGH CONF,JUNE 75)
PHI ANGLE NORMALIZED TO 2.72 BARS USING BALIGH'S EXPRESSION (ASCE,J-GED,NOV 76)
MODIFIED MAYNE AND KULHAWY FORMULA USED FOR OCR IN SANDS (ASCE,J-GED,JUNE 82)

LOCATION: FOOTING NO.2 BACKFILL MATERIAL STATIC PUSH AS FAR AS POSSIBLE THEN DRIVEN
PERFORMED - DATE: 04 NOV 88
BY: M GRILLS WITH SAFETY SPT HAMMER WITH 18 INCH DROP HEIGHT

CALIBRATION INFORMATION:
DELTA A = .35 BARS DELTA B = .52 BARS GAGE 0 = .05 BARS GWT DEPTH=20.00 M
ROD DIA.= 3.70 CM FR.RED.DIA.= 4.80 CM ROD WT.= 6.60 KG/M DELTA/PHI= .50 BLADE T=13.70 MM

1 BAR = 1.019 KG/CM2 = 1.044 TSF = 14.51 PSI ANALYSIS USES H2O UNIT WEIGHT = 1.000 T/M3

Z (M)	THRUST (KG)	A (BAR)	B (BAR)	ED (BAR)	ID	KD	UO (BAR)	GAMMA (T/M3)	SV (BAR)	PC (BAR)	OCR	KO	CU (BAR)	PHI (DEG)	M (BAR)	SOIL TYPE
.30	84.	1.15	6.30	156.	3.64	30.90	.000	1.360	.040	23.28	*****	4.27		13.0	556.4	SAND
.61	168.	3.40	11.80	274.	2.38	40.84	.000	1.360	.081	*****	*****	5.58		8.5	1051.4	SILTY SAND
.91	173.	2.05	12.40	345.	5.31	14.78	.000	1.736	.127	7.58	59.74	2.28		18.5	991.2	SAND
1.22	271.	5.05	18.60	462.	2.82	26.23	.000	1.736	.180	*****	*****	3.80		11.8	1576.9	SILTY SAND
1.52	365.	4.55	17.00	422.	2.85	18.50	.000	1.736	.231	28.07	*****	2.76		18.4	1300.5	SILTY SAND
1.83	406.	6.90	25.00	628.	2.85	22.28	.000	1.791	.285	*****	*****	3.30		14.2	2045.5	SILTY SAND
NEW DA =		.35	NEW DB =	1.15												
2.13	2500.	5.05	26.50	727.	4.81	12.91	.000	1.791	.337	5.98	17.74	1.58		40.3	1992.8	SAND
2.44	2600.	3.85	23.50	661.	5.88	8.33	.000	1.620	.389	2.71	6.97	.97		41.8	1548.5	SAND
2.74	2200.	3.80	23.60	667.	6.03	7.29	.000	1.620	.437	2.63	6.01	.92		40.3	1483.9	SAND
3.05	2900.	50.00	50.00	-52.	-.03		.000	P01 = 50.37		P0 = 50.30		P1 =	48.80			QUESTIONABLE
3.20	3900.	8.30	42.20	1180.	4.87	13.67	.000	1.646	.511	10.21	19.99	1.67		40.8	3300.8	SAND
3.35	4400.	10.00	43.80	1177.	3.91	16.24	.000	1.646	.535	15.18	28.38	2.00		40.5	3482.4	SAND

END OF SOUNDING

THRUST AND UNIT WEIGHT MEASURED

TABLE A15

ONTARIO HYDRO CIVIL RESEARCH TEST NO. D-3DBAC.DIL
FILE NAME: ESSA T5 - INCLINED PLATE ANCHOR TESTING
FILE NUMBER: 43-273

RECORD OF DILATOMETER TEST NO. D-3DBAC.DIL
USING DATA REDUCTION PROCEDURES IN MARCHETTI (ASCE,J-GED,MARCH 80)
KO IN SANDS DETERMINED USING SCHMERTMANN METHOD (1983)
PHI ANGLE CALCULATION BASED ON DURSUNOGLU AND MITCHELL (ASCE,RALEIGH CONF,JUNE 75)
PHI ANGLE NORMALIZED TO 2.72 BARS USING BALIGH'S EXPRESSION (ASCE,J-GED,NOV 76)
MODIFIED MAYNE AND KULHAWY FORMULA USED FOR OCR IN SANDS (ASCE,J-GED,JUNE 82)

LOCATION: FOOTING NO.3 BACKFILL MATERIAL STATIC PUSH AS FAR AS POSSIBLE THEN DRIVEN
PERFORMED - DATE: 04 NOV 88
BY: M GRILLS WITH SAFETY SPT HAMMER WITH 18 INCH DROP HEIGHT

CALIBRATION INFORMATION:
DELTA A = .33 BARS DELTA B = 1.10 BARS GAGE 0 = .05 BARS GWT DEPTH=20.00 M
ROD DIA.= 3.70 CM FR.RED.DIA.= 4.80 CM ROD WT.= 6.60 KG/M DELTA/PHI= .50 BLADE T=13.70 MM

1 BAR = 1.019 KG/CM2 = 1.044 TSF = 14.51 PSI ANALYSIS USES H2O UNIT WEIGHT = 1.000 T/M3

Z (M)	THRUST (KG)	A (BAR)	B (BAR)	ED (BAR)	ID	KD	UO (BAR)	GAMMA (T/M3)	SV (BAR)	PC (BAR)	OCR	KO	CU (BAR)	PHI (DEG)	M (BAR)	SOIL TYPE
.30	31.	.10	2.30	28.	2.37	5.99	.000	1.947	.057	.52	9.07	1.22		17.2	57.1	SILTY SAND
.61	53.	.95	4.20	66.	1.68	9.80	.000	1.947	.116	8.79	75.63	1.87		8.6	164.5	SANDY SILT
.91	62.	.80	3.85	59.	1.70	5.74	.000	1.985	.174	2.54	14.60	1.34		11.9	116.3	SANDY SILT
1.22	76.	.90	4.00	61.	1.60	4.68	.000	1.985	.234	2.20	9.39	1.20		13.1	107.7	SANDY SILT
1.52	82.	1.25	1.25	-50.	-.93		.000	P01 =	1.60	P0 =	1.53	P1 =	.10			QUESTIONABLE
1.83	140.	5.75	14.60	270.	1.38	16.55	.000	1.604	.342	*****	*****	2.83		3.4	804.8	SANDY SILT
1.95	240.	2.40	11.80	290.	3.67	6.29	.000	1.746	.362	4.00	11.03	1.29		19.6	609.2	SAND

END OF SOUNDING

THRUST AND UNIT WEIGHT MEASURED

TABLE A16

ONTARIO HYDRO CIVIL RESEARCH TEST NO. D-4NAT.DIL
FILE NAME: ESSA TS - INCLINED PLATE ANCHOR TESTING
FILE NUMBER: 43-273

RECORD OF DILATOMETER TEST NO. D-4NAT.DIL
USING DATA REDUCTION PROCEDURES IN MARCHETTI (ASCE,J-GED,MARCH 80)
KO IN SANDS DETERMINED USING SCHMERTMANN METHOD (1983)
PHI ANGLE CALCULATION BASED ON DURGUNOGLU AND MITCHELL (ASCE,RALEIGH CONF,JUNE 75)
PHI ANGLE NORMALIZED TO 2.72 BARS USING BALIGH S EXPRESSION (ASCE,J-GED,NOV 76)
MODIFIED MAYNE AND KULHAWY FORMULA USED FOR OCR IN SANDS (ASCE,J-GED,JUNE 82)

LOCATION: FOOTING NO.4 NATIVE MATERIAL STATIC PUSH AS FAR AS POSSIBLE THEN DRIVEN
PERFORMED - DATE: 02 NOV 88
BY: M GRILLS WITH SAFETY SPT HAMMER WITH 18 INCH DROP HEIGHT

CALIBRATION INFORMATION:
DELTA A = .30 BARS DELTA B = .60 BARS GAGE 0 = .05 BARS GWT DEPTH=20.00 M
ROD DIA.= 3.70 CM FR.RED.DIA.= 4.80 CM ROD WT.= 6.60 KG/M DELTA/PHI= .50 BLADE T=13.70 MM

1 BAR = 1.019 KG/CM2 = 1.044 TSF = 14.51 PSI ANALYSIS USES H2O UNIT WEIGHT = 1.000 T/M3

Z (M)	THRUST (KG)	A (BAR)	B (BAR)	ED (BAR)	ID	KD	UO (BAR)	GAMMA (T/M3)	SV (BAR)	PC (BAR)	OCR	KO	CU (BAR)	PHI (DEG)	M (BAR)	SOIL TYPE
.30	34.	.60	3.30	66.	2.49	14.34	.000	1.815	.053	8.60	*****	2.38		8.4	186.3	SILTY SAND
.61	49.	.61	3.35	67.	2.52	7.10	.000	1.815	.108	2.10	19.42	1.47		12.4	146.9	SILTY SAND
.91	64.	1.10	4.95	107.	2.58	7.45	.000	1.802	.161	5.01	31.06	1.57		10.3	240.3	SILTY SAND
1.22	79.	1.30	4.85	97.	1.96	6.54	.000	1.836	.217	5.00	23.06	1.46		11.0	203.0	SILTY SAND
1.52	133.	5.20	14.20	295.	1.69	18.63	.000	1.836	.271	*****	*****	3.06		3.4	911.6	SANDY SILT
1.83	2600.	4.80	25.80	732.	5.22	12.46	.000	1.700	.325	5.17	15.93	1.49		41.1	1983.4	SAND
2.13	3600.	7.85	36.20	1000.	4.28	17.96	.000	1.686	.374	12.59	33.61	2.18		40.7	3055.1	SAND
2.44	4400.	8.05	41.40	1182.	5.10	15.68	.000	1.686	.426	10.39	24.41	1.85		42.1	3459.5	SAND
2.74	5600.	9.80	43.60	1199.	4.11	17.68	.000	1.686	.475	14.54	30.59	2.07		42.5	3643.5	SAND
3.05	4500.	11.60	49.80	1359.	3.92	19.00	.000	1.609	.526	20.68	39.36	2.35		40.0	4223.4	SAND
3.35	4900.	10.00	49.00	1388.	4.79	14.57	.000	1.609	.573	12.69	22.15	1.76		41.5	3964.8	SAND
3.65	7300.	13.00	54.40	1476.	3.79	18.10	.000	1.609	.620	20.05	32.33	2.13		42.7	4517.7	SAND

END OF SOUNDING

THRUST AND UNIT WEIGHT MEASURED

TABLE A17

ONTARIO HYDRO CIVIL RESEARCH — TEST NO. D-4DBAC.DIL
FILE NAME: ESSA T5 - INCLINED PLATE ANCHOR TESTING
FILE NUMBER: 43-273

RECORD OF DILATOMETER TEST NO. D-4DBAC.DIL
USING DATA REDUCTION PROCEDURES IN MARCHETTI (ASCE,J-GED,MARCH 80)
KO IN SANDS DETERMINED USING SCHMERTMANN METHOD (1983)
PHI ANGLE CALCULATION BASED ON DURGUNOGLU AND MITCHELL (ASCE,RALEIGH CONF,JUNE 75)
PHI ANGLE NORMALIZED TO 2.72 BARS USING BALIGH'S EXPRESSION (ASCE,J-GED,NOV 76)
MODIFIED MAYNE AND KULHAWY FORMULA USED FOR OCR IN SANDS (ASCE,J-GED,JUNE 82)

LOCATION: FOOTING NO.4 BACKFILL MATERIAL STATIC PUSH AS FAR AS POSSIBLE THEN DRIVEN
PERFORMED - DATE: 04 NOV 88
BY: M GRILLS WITH SAFETY SPT HAMMER WITH 18 INCH DROP HEIGHT

CALIBRATION INFORMATION:
DELTA A = .33 BARS DELTA B = 1.10 BARS GAGE 0 = .05 BARS GWT DEPTH=20.00 M
ROD DIA.= 3.70 CM FR.RED.DIA.= 4.80 CM ROD WT.= 6.60 KG/M DELTA/PHI= .50 BLADE T=13.70 MM

1 BAR = 1.019 KG/CM2 = 1.044 TSF = 14.51 PSI ANALYSIS USES H2O UNIT WEIGHT = 1.000 T/M3

Z (M)	THRUST (KG)	A (BAR)	B (BAR)	ED (BAR)	ID	KD	UO (BAR)	GAMMA (T/M3)	SV (BAR)	PC (BAR)	OCR	KO	CU (BAR)	PHI (DEG)	M (BAR)	SOIL TYPE
*****	******	*****	*****	*****	*****	*****	******	******	******	*****	*****	*****	*****	*****	******	**********
.30	46.	1.00	5.25	103.	2.60	23.73	.000	1.614	.048	80.04	*****	3.55		5.8	340.9	SILTY SAND
.61	67.	.50	3.90	72.	3.04	6.86	.000	1.761	.099	1.20	12.04	1.34		17.8	156.0	SILTY SAND
.91	65.	1.75	6.30	114.	1.75	12.40	.000	1.761	.151	69.50	*****	2.25		5.5	307.3	SANDY SILT
1.22	68.	.30	2.40	24.	1.29	2.66	.000	1.788	.205	.63	3.08	.87		17.8	29.4	SANDY SILT
1.52	44.	.10	2.25	26.	2.20	1.33	.000	1.788	.258	.45	1.75	.76		15.4	22.3	SILTY SAND
1.83	225.	1.15	6.05	126.	2.90	4.02	.000	1.788	.312	1.34	4.29	.92		24.1	215.4	SILTY SAND

END OF SOUNDING

THRUST AND UNIT WEIGHT MEASURED

TABLE A18

ONTARIO HYDRO CIVIL RESEARCH — TEST NO. TESTPIT.DIL
FILE NAME: ESSA TS - INCLINED PLATE ANCHOR TESTING
FILE NUMBER: 43-273

RECORD OF DILATOMETER TEST NO. TESTPIT.DIL
USING DATA REDUCTION PROCEDURES IN MARCHETTI (ASCE,J-GED,MARCH 80)
KO IN SANDS DETERMINED USING SCHMERTMANN METHOD (1983)
PHI ANGLE CALCULATION BASED ON DURGUNOGLU AND MITCHELL (ASCE,RALEIGH CONF,JUNE 75)
PHI ANGLE NORMALIZED TO 2.72 BARS USING BALIGH'S EXPRESSION (ASCE,J-GED,NOV 76)
MODIFIED MAYNE AND KULHAWY FORMULA USED FOR OCR IN SANDS (ASCE,J-GED,JUNE 82)

LOCATION: TEST PIT BACKFILL MATERIAL STATIC PUSH AS FAR AS POSSIBLE THEN DRIVEN
PERFORMED - DATE: 04 NOV 88
BY: M GRILLS WITH SAFETY SPT HAMMER WITH 18 INCH DROP HEIGHT

CALIBRATION INFORMATION:
DELTA A = .18 BARS DELTA B = .25 BARS GAGE 0 = .05 BARS GWT DEPTH=20.00 M
ROD DIA.= 3.70 CM FR.RED.DIA.= 4.80 CM ROD WT.= 6.60 KG/M DELTA/PHI= .50 BLADE T=13.70 MM

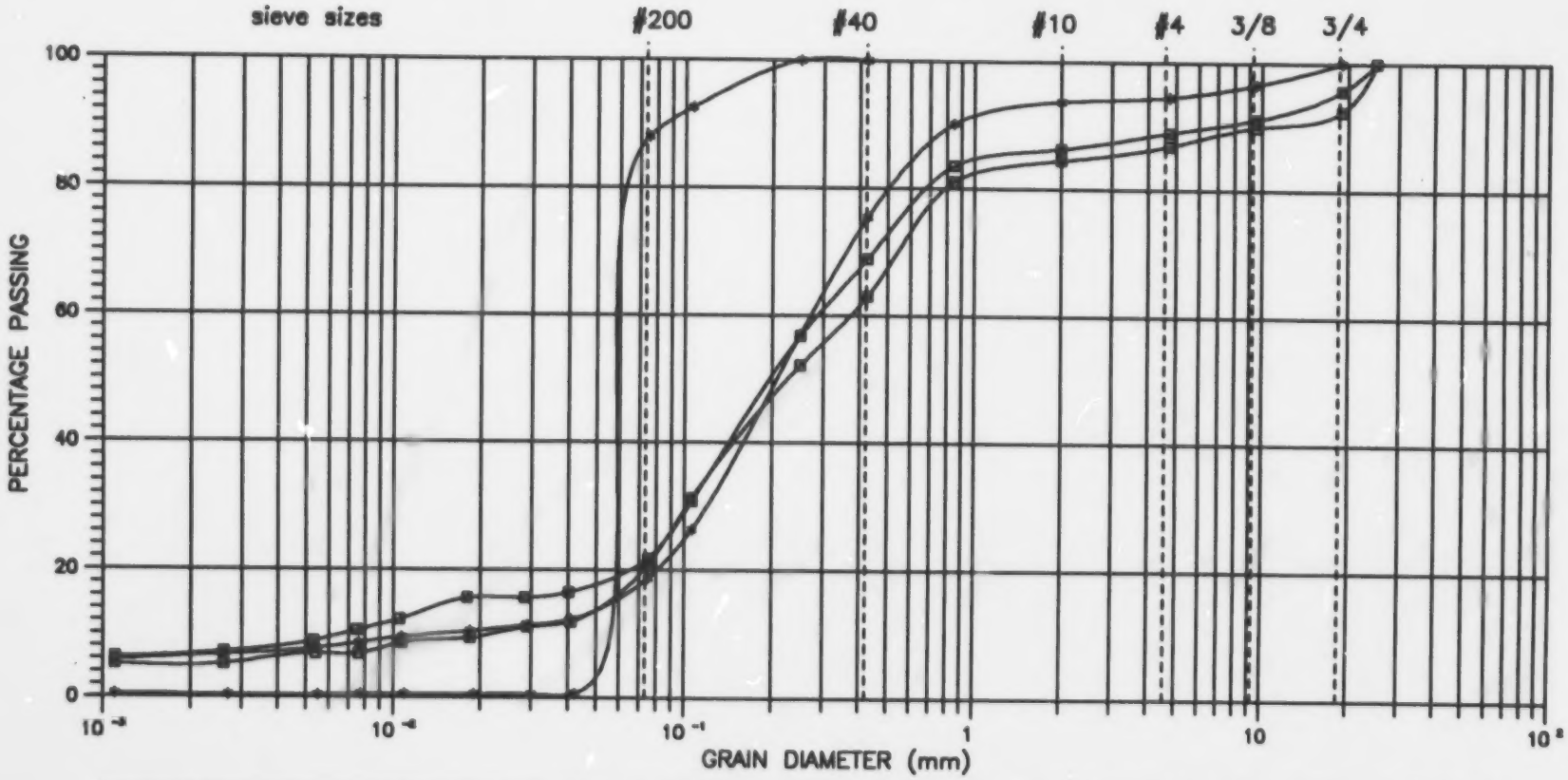
1 BAR = 1.019 KG/CM2 = 1.044 TSF = 14.51 PSI ANALYSIS USES H2O UNIT WEIGHT = 1.000 T/M3

Z (M)	THRUST (KG)	A (BAR)	B (BAR)	ED (BAR)	ID	KD	UO (BAR)	GAMMA (T/M3)	SV (BAR)	PC (BAR)	OCR	KO	CU (BAR)	PHI (DEG)	M (BAR)	SOIL TYPE
.30	84.	1.05	5.40	143.	4.18	21.87	.000	1.515	.045	6.34	*****	3.12		16.9	462.9	SAND
.61	94.	.50	2.40	54.	2.77	6.11	.000	1.515	.091	.70	7.73	1.14		22.7	110.6	SILTY SAND
.91	63.	.45	2.30	52.	2.93	3.75	.000	1.515	.136	.60	4.41	.95		18.9	85.0	SILTY SAND
1.22	55.	.30	1.85	41.	3.14	2.06	.000	1.515	.182	.41	2.25	.78		18.4	46.0	SILTY SAND
1.52	86.	.35	2.25	54.	3.80	1.80	.000	1.515	.226	.42	1.83	.70		21.2	54.0	SAND
1.83	116.	8.35	12.40	132.	.46	30.46	.000	1.515	.272	19.07	69.98	3.52	1.803		468.8	SILTY CLAY
2.13	600.	.55	1.95	35.	1.61	1.99	.000	1.515	.317	.32	1.00	.41		35.8	33.7	SANDY SILT
2.59	400.	.60	1.40	13.	.55	1.85	.000	1.515	.385	.34	.88	.50	.077		11.5	SILTY CLAY
2.89	1300.	1.90	14.50	443.	8.99	3.31	.000	1.515	.430	.70	1.62	.49		38.9	682.2	SAND
3.20	3000.	4.10	24.50	728.	6.49	6.79	.000	1.515	.476	2.12	4.45	.77		42.4	1574.0	SAND
3.35	2800.	3.20	18.00	524.	5.78	5.24	.000	1.515	.498	1.28	2.56	.58		42.5	1015.0	SAND

END OF SOUNDING

THRUST AND UNIT WEIGHT MEASURED

MECANICAL ANALYSIS – ESSA T.S ANCHOR NO. 1

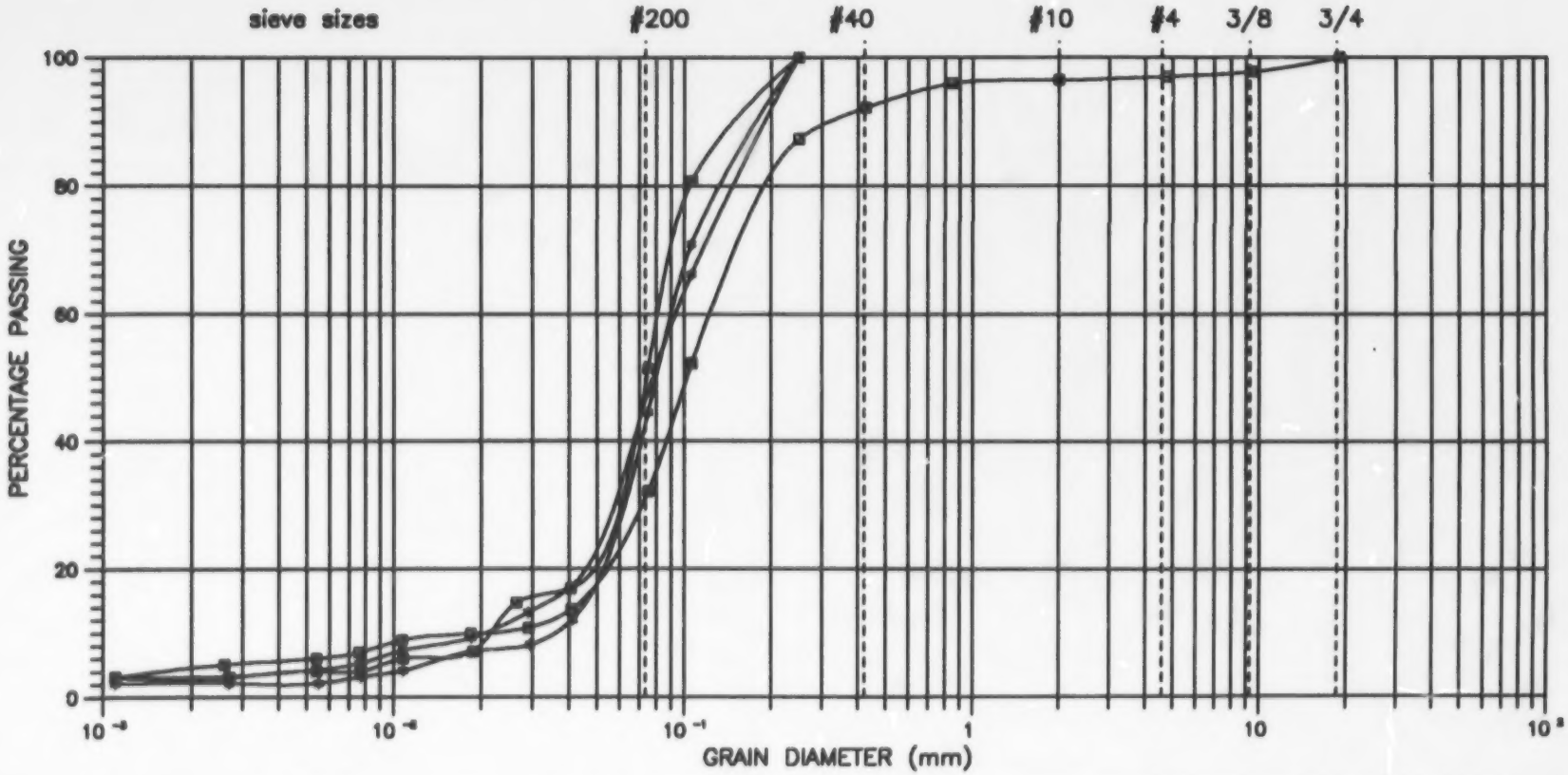


NATIVE SOIL (1AS6)
NATIVE SOIL (1AS3)
BACKFILL MATERIAL (1CS6)
BACKFILL MATERIAL (1CS3)

ONTARIO HYDRO
RESEARCH DIVISION

FIGURE A19

MECANICAL ANALYSIS – ESSA T.S ANCHOR NO. 2



clay	to silt	sand			gravel	
		fine	medium	coarse	fine	coarse

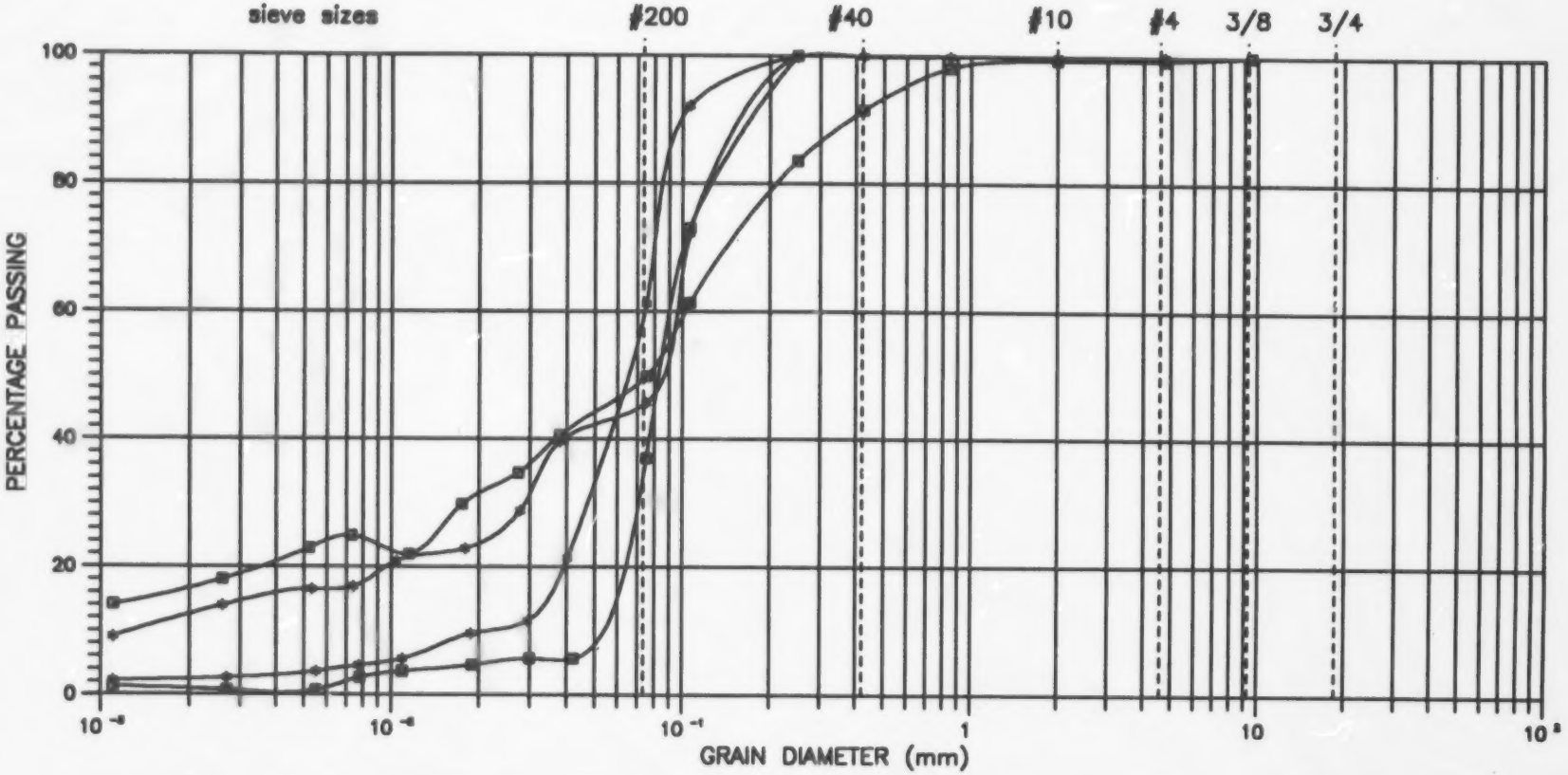
unified soil classification

NATIVE SOIL (2AS4)
NATIVE SOIL (2AS7)
BACKFILL MATERIAL (2DS3)
BACKFILL MATERIAL (2DS7)

ONTARIO HYDRO
RESEARCH DIVISION

FIGURE A20

MECANICAL ANALYSIS – ESSA T.S ANCHOR NO. 3



ONTARIO HYDRO
RESEARCH DIVISION

FIGURE A21

MECANICAL ANALYSIS – ESSA T.S ANCHOR NO. 4

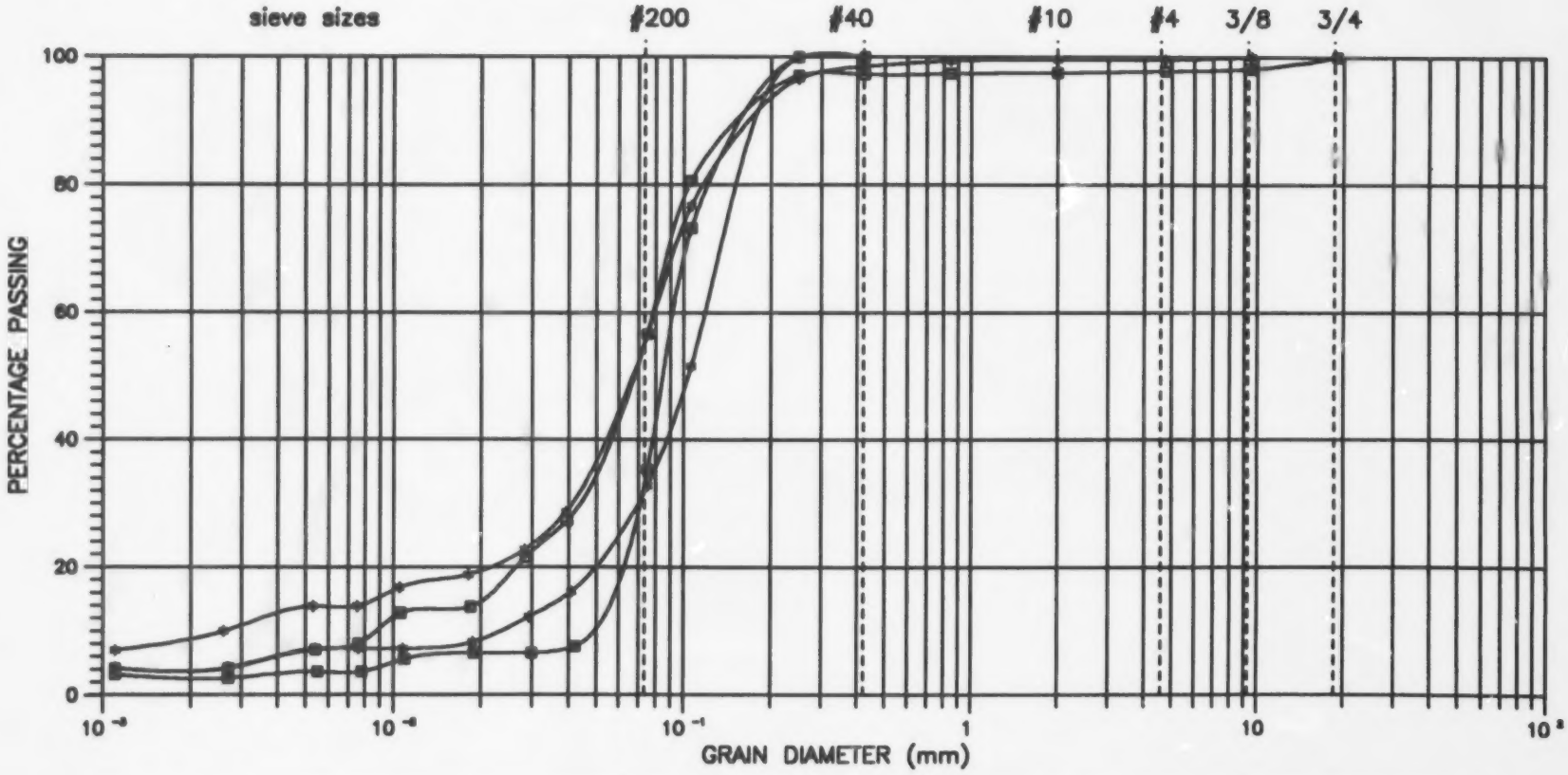


FIGURE A22

ONTARIO HYDRO
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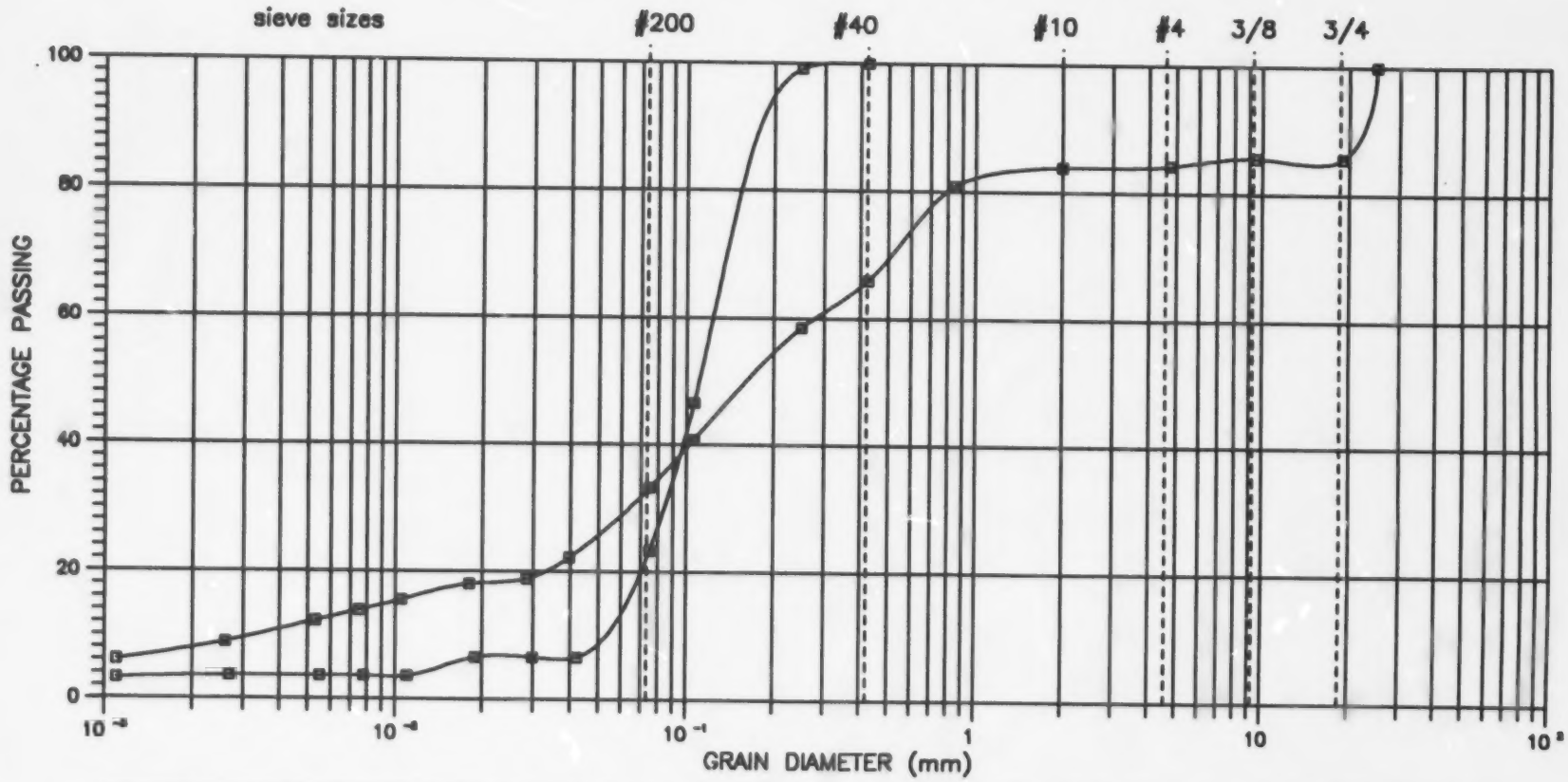
MECANICAL ANALYSIS – ESSA T.S TEST PIT S–3,S–7



BACKFILL MATERIAL (S3)
BACKFILL MATERIAL (S7)

ONTARIO HYDRO
RESEARCH DIVISION

FIGURE A23

APPENDIX B

INSTRUMENTATION OF TEST ANCHORS

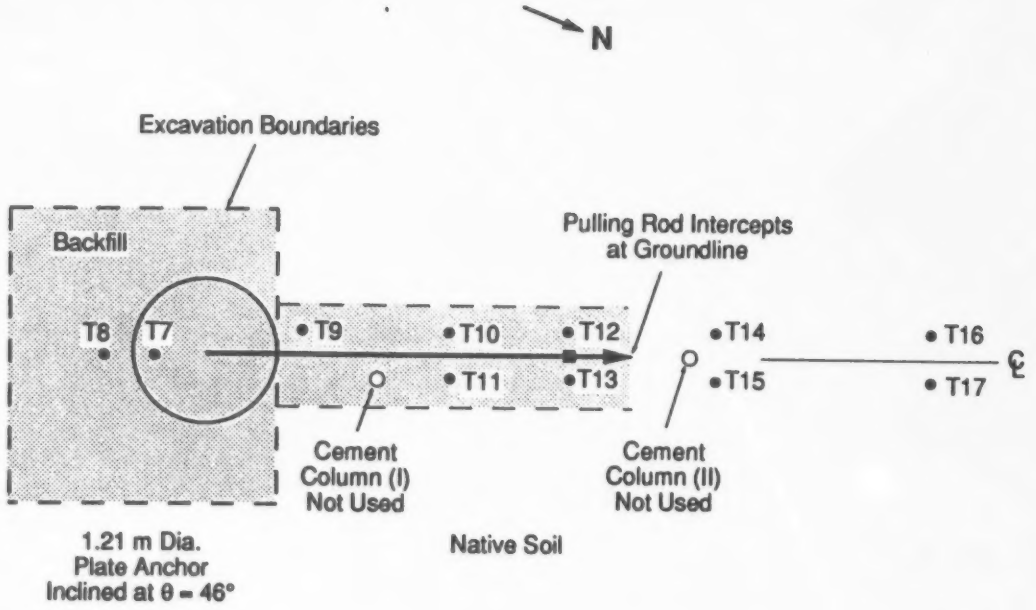


FIGURE B1

PLAN VIEW OF PLATE ANCHOR INSTRUMENTATION - ANCHOR #1

179226-RD
JA 12 DISK

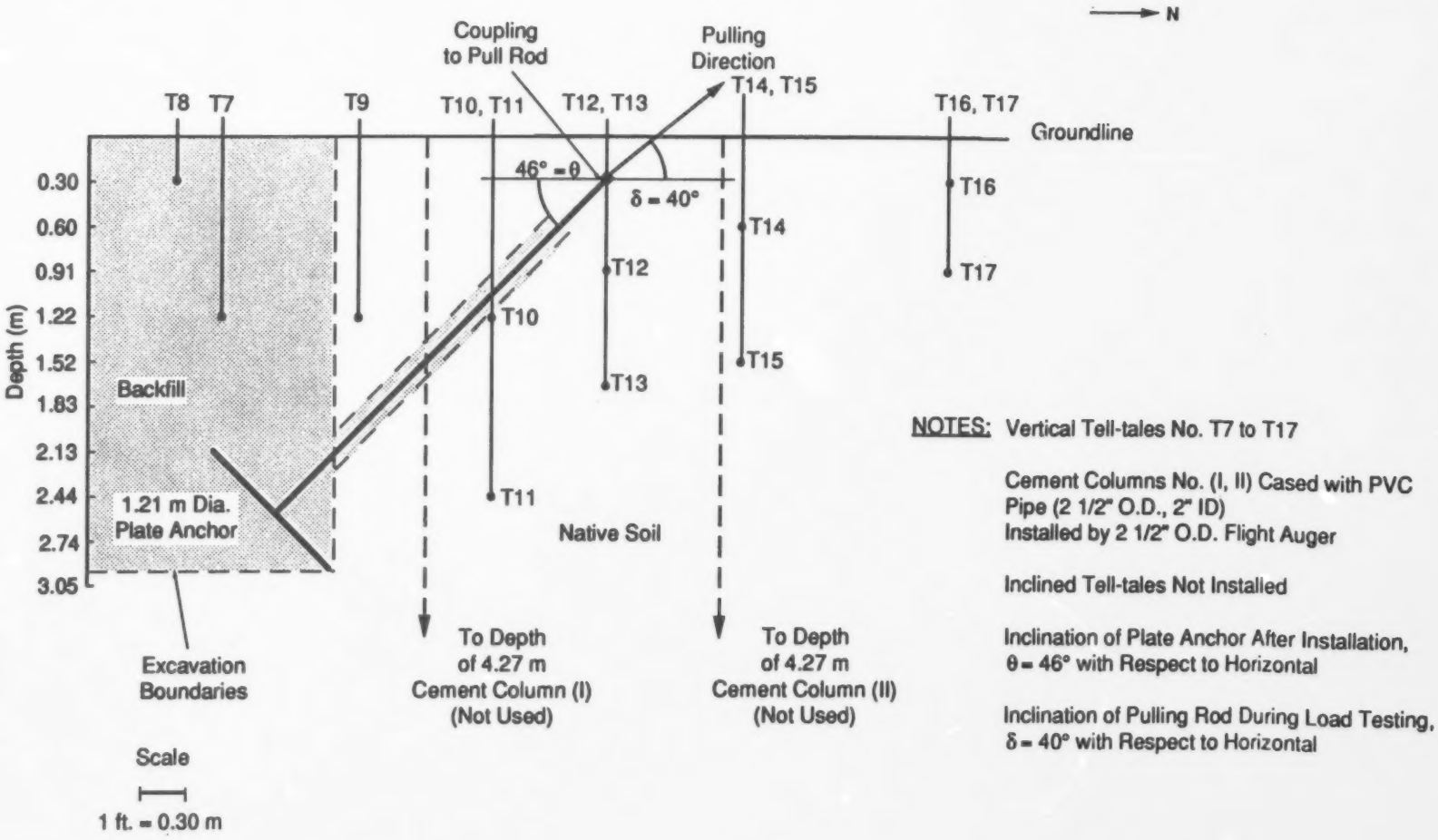
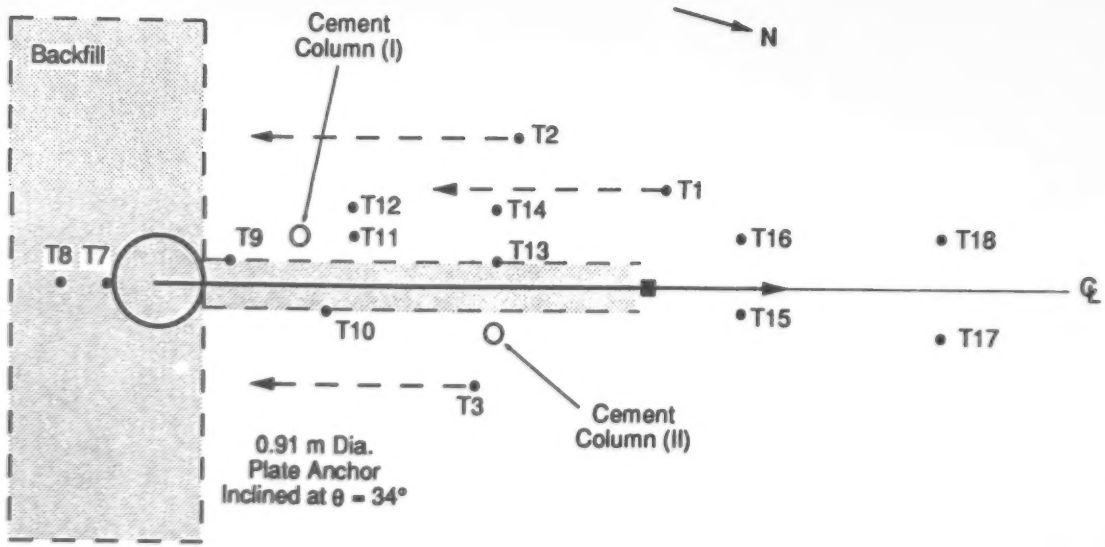


FIGURE B2

CROSS-SECTION OF INSTRUMENTATION ALONG CENTRELINE OF PLATE ANCHOR - ANCHOR #1



NOTES: Inclined Tell-tales No. 1 at 51°
Inclined Tell-tales No. 2 at 50°
Inclined Tell-tales No. 3 at 53°

Vertical Tell-tales No. T7 to T18

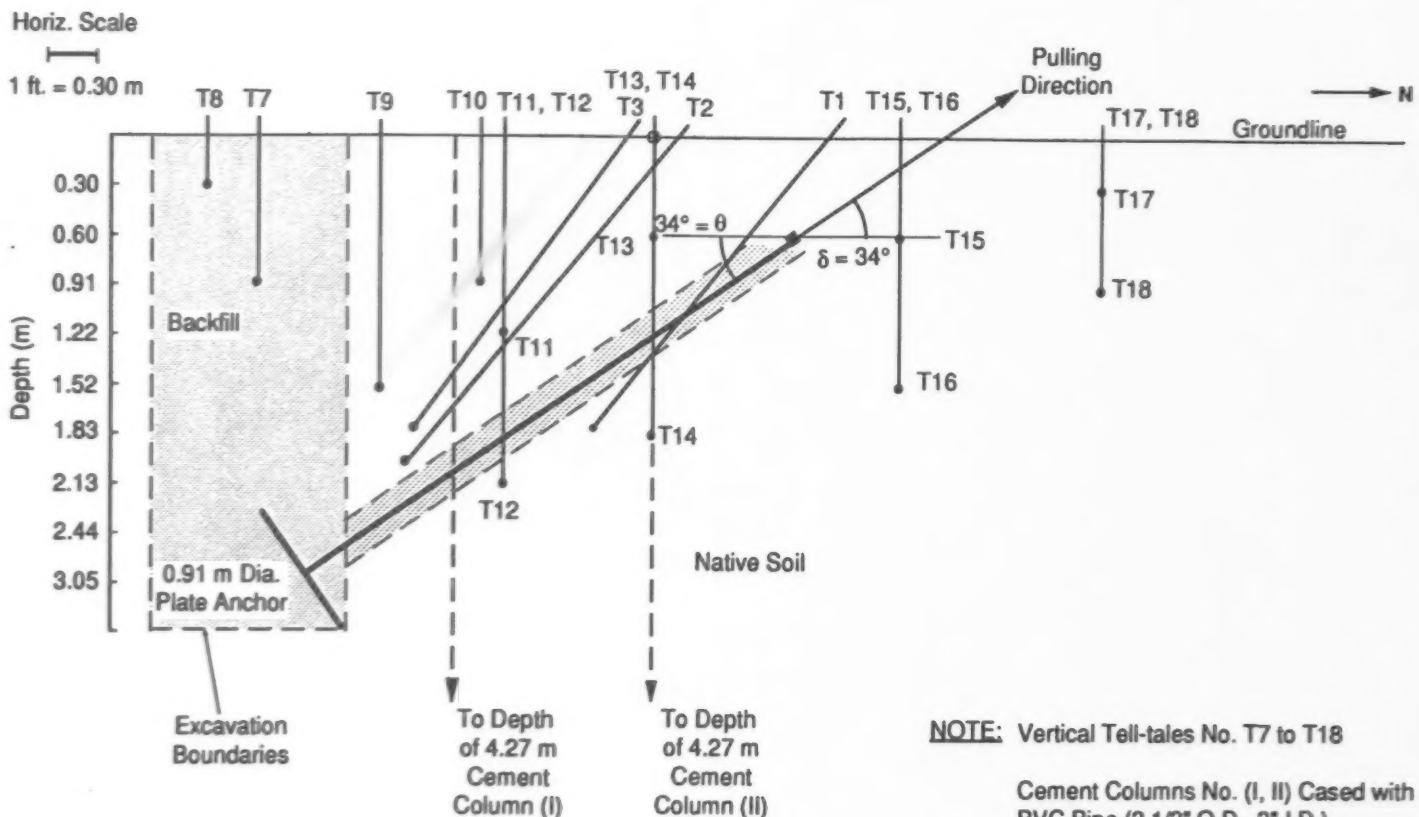
Scale

1 ft. = 0.30 m

FIGURE B3

PLAN VIEW OF PLATE ANCHOR INSTRUMENTATION - ANCHOR #2

179229-RD
JA 12 DISK



NOTE: Vertical Tell-tales No. T7 to T18

Cement Columns No. (I, II) Cased with PVC Pipe (2 1/2" O.D., 2" I.D.) Installed by 2 1/2" O.D. Flight Auger

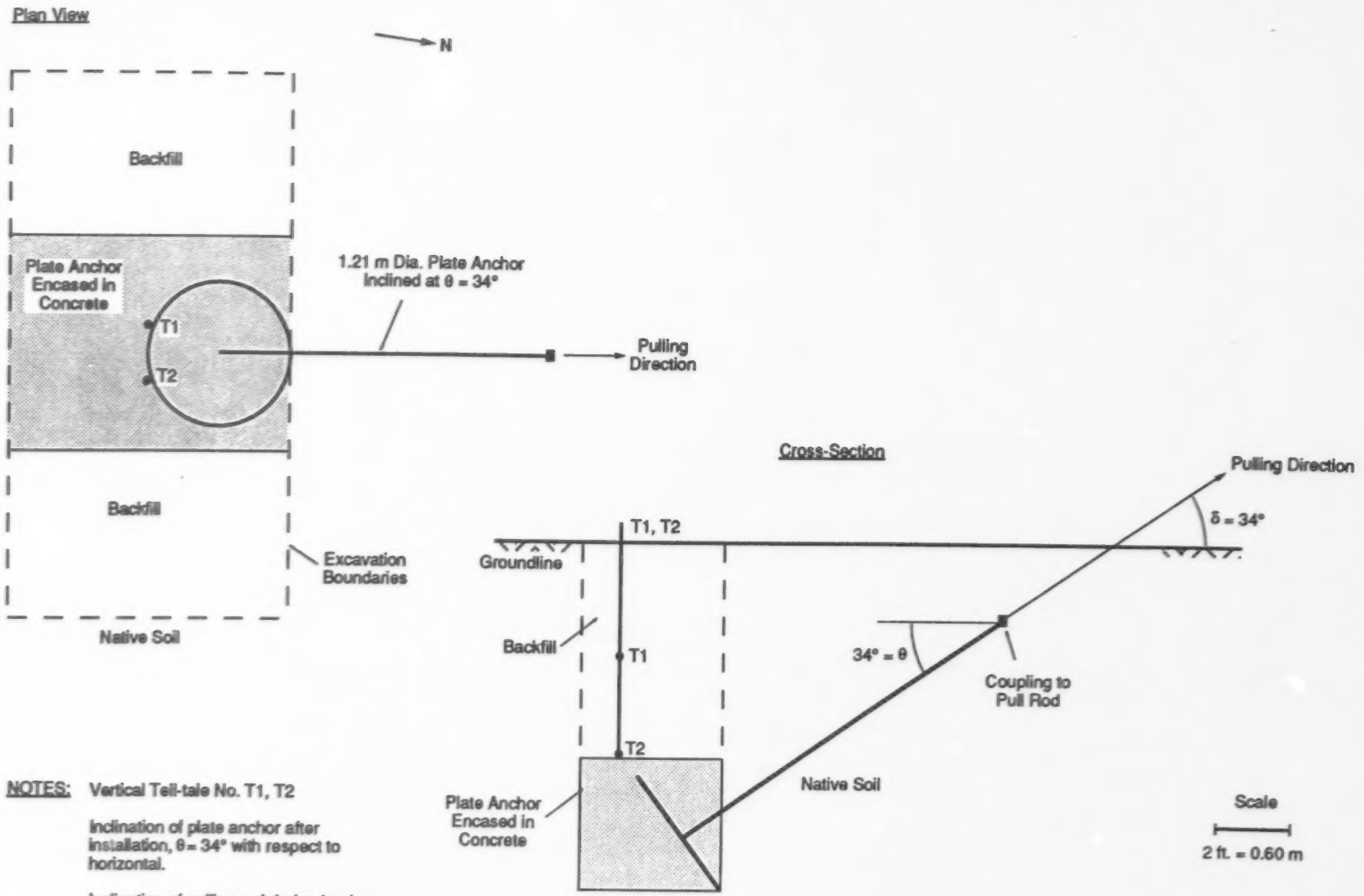
Inclined Tell-tales No. T1 at 51°
Inclined Tell-tales No. T2 at 50°
Inclined Tell-tales No. T3 at 53°
Inclination of Plate Anchor After Installation, $\theta = 34°$ with Respect to Horizontal

Inclination of Pulling Rod During Load Testing, $\delta = 34°$ with Respect to Horizontal

FIGURE B4

CROSS-SECTION OF INSTRUMENTATION ALONG CENTRELINE OF PLATE ANCHOR - ANCHOR #2

179222-RD
JA 12 DISK



NOTES: Vertical Tell-tale No. T1, T2

Inclination of plate anchor after installation, θ = 34° with respect to horizontal.

Inclination of pulling rod during load testing, δ = 34° with respect to horizontal.

FIGURE B5

INSTRUMENTATION OF PLATE ANCHOR - ANCHOR #3

179230-RD
JA 12 DISK

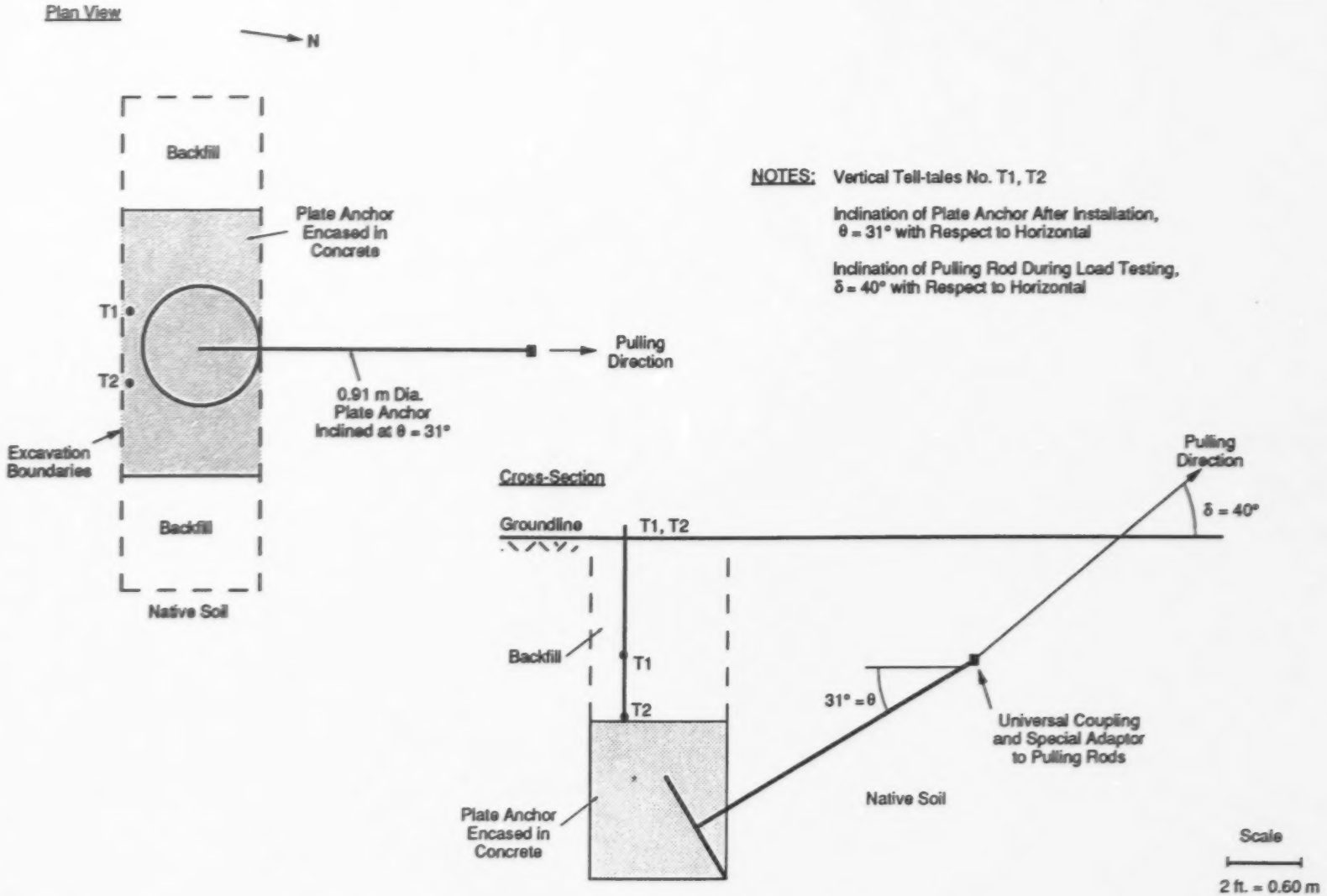


FIGURE B6

INSTRUMENTATION OF PLATE ANCHOR - ANCHOR #4

17823-S12-RD

APPENDIX C

FIELD LOAD TESTING RESULTS

TABLE C1

RESULTS OF FIELD LOAD TESTING OF INCLINED PLATE ANCHORS

BSSA TS - PLATE ANCHOR LOAD TESTING
FOOTING NO. 1 NOV.10/88
1.21 m DIAMETER PLATE BACKFILLED WITH NATIVE SOIL
PLATE ANCHOR ROD INCLINED AT 45 degrees (wrt HORIZONTAL)
INCLINATION OF PULLING RODS AT TIME OF TESTING WAS 60 degrees (wrt HORIZONTAL)

	HOLD TIME (min.)	APPLIED LOAD (kN)	MEASURED DISPLACEMENTS: DISPL. * FULL ROD (mm)	TELL-TALE T8 (mm)	TELL-TALE T7 (mm)	TELL-TALE T9 (mm)	TELL-TALE T11 (mm)	TELL-TALE T10 (mm)	TELL-TALE T12 (mm)	TELL-TALE T13 (mm)	TELL-TALE T15 (mm)	TELL-TALE T14 (mm)	TELL-TALE T17 (mm)	TELL-TALE T16 (mm)	VERT. COMPONENT OF FULL ROD DISPL. (mm)	HORIZ. COMPONENT OF PULL ROD DISPL. (mm)
***		0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
***		33.375	30.734	0.0254	0.0508	0.0254	0	0.0254	-0.1778	-0.2032	-0.0762	-0.0508	0.0254	-0.0254	19.76	23.54
		44.5	33.4264	0.0508	0.0762	0.0254	-0.0254	-0.0254	-0.0762	-0.1016	-0.127	-0.0508	0.0254	-0.0254	1.73	2.06
**		44.5	33.4264	0.0508	0.0762	0.0254	-0.0254	-0.0254	-0.9144	-1.143	-0.9398	-0.9128	0.0254	-0.0254	1.73	2.06
		75.25	48.3362	0.127	0.1524	0.127	-0.0508	-0.0254	-0.889	-1.1684	-0.9906	-0.8636	0	-0.0508	11.51	13.48
		89	53.6782	0.1524	0.2286	0.1524	-0.0508	0	-0.9398	-1.1684	-0.9906	-0.8636	0.0254	-0.0508	14.74	17.57
		111.25	61.9362	0.1524	1.41224	0.2032	-0.0508	0.0254	-0.9398	-1.1684	-1.016	-0.889	-0.0254	-0.0508	19.48	23.21
		133.5	68.6562	0.2032	0.3556	0.254	-0.0508	-0.0254	-0.9398	-1.1684	-1.016	-0.889	0	0	24.38	29.05
		155.75	74.2442	0.254	0.4572	0.3048	-0.0508	0.0254	-0.889	-1.143	-1.016	-0.8636	0.0254	-0.0254	27.97	33.33
		178	78.8702	0.3048	0.6096	0.381	0	0.0508	-0.889	-1.143	-0.9906	-0.8382	0.0508	-0.0254	31.09	37.03
	5 MIN.	178	82.2452	0.3048	0.6096	0.3556	-0.0508	0	-0.889	-1.1684	-0.9906	-0.8636	0.0508	-0.1016	33.11	39.46
		133.5	81.407	0.254	0.5588	0.3048	-0.1016	-0.0508	-0.9398	-1.1938	-0.9906	-0.8636	-0.1016	-0.1524	32.57	38.82
		89	78.5114	0.2286	0.508	0.254	-0.127	-0.0508	-0.9398	-1.1938	-0.9906	-0.8382	-0.1016	-0.1524	30.71	36.60
		44.5	73.8124	0.1778	0.4064	0.1778	-0.127	-0.1016	-0.9398	-1.1938	-1.016	-0.8636	-0.1016	-0.1524	27.69	33.00
		89	75.9714	0.1778	0.4064	0.2032	-0.127	-0.0762	-0.9906	-1.2192	-1.0414	-0.9144	-0.1016	-0.1778	29.08	34.65
		131.375	79.0702	0.2286	0.4826	0.254	-0.127	-0.0508	-0.9652	-1.2192	-1.0414	-0.9144	-0.0762	-0.1524	31.07	37.03
		178	82.3722	0.3048	0.6096	0.3302	-0.0508	-0.0254	-0.9398	-1.1938	-1.0414	-0.9144	-0.1016	-0.127	33.19	39.56
		200.25	84.709	0.3302	0.7366	0.381	-0.0508	-0.0254	-0.9652	-1.1938	-1.0668	-0.9144	-0.0508	-0.1016	34.69	41.35
		222.5	88.7222	0.4064	0.889	0.4826	-0.0508	0.0254	-0.9398	-1.1938	-1.0414	-0.889	-0.0508	-0.1016	37.27	44.42
**		222.5	88.7222	0.4064	0.889	0.4826	-0.0508	0.0254	-0.9398	-1.1938	-1.0414	-0.889	-0.0508	-0.1016	37.27	44.42
		244.75	90.7796	0.508	1.1684	0.635	0	0.0508	-0.889	-1.143	-0.9636	-0.8128	-0.0508	-0.0762	38.60	46.00
		267	96.4946	0.6604	1.4224	0.7874	0	0.1016	-0.889	-1.1684	-0.9636	-0.8128	-0.0254	-0.0762	42.27	50.38
		289.25	102.8466	0.7366	1.7526	1.016	0.1016	0.1778	-0.889	-1.143	-0.8382	-0.7874	-0.0254	-0.0254	46.35	55.24
	5 MIN.	289.25	110.2186	0.8144	2.1082	1.1938	0.1016	0.2286	-0.8636	-1.143	-0.8128	-0.7366	0.0254	-0.0254	51.09	60.88
	10 MIN.	289.25	110.7548	0.9144	2.1082	1.2192	0.1016	0.2286	-0.8636	-1.143	-0.7874	-0.762	0.0254	-0.0254	51.46	61.33
		309.275	112.2426	0.9906	2.2352	1.2954	0.1016	0.2286	-0.8636	-1.143	-0.7874	-0.7366	0.0508	-0.0254	52.39	62.44
	5 MIN.	309.275	115.6446	1.0668	2.4384	1.4478	0.127	0.254	-0.8636	-1.143	-0.7874	-0.7112	0.1016	-0.0254	54.52	64.97
		333.75	117.8306	1.1684	2.6162	1.5494	0.127	0.3048	-0.8382	-1.1176	-0.762	-0.7366	0.0508	-0.0254	55.93	66.72
	5 MIN.	333.75	123.2916	1.3716	3.048	1.8288	0.1524	0.3302	-0.8382	-1.1176	-0.762	-0.7112	0.127	-0.0254	59.45	70.90
	10 MIN.	333.75	124.4054	1.4224	3.1496	1.9304	0.1778	0.3556	-0.8128	-1.0922	-0.7366	-0.7112	0.1524	-0.0508	60.26	71.82
		289.25	124.1256	1.4224	3.1242	1.8796	0.2032	0.3556	-0.8128	-1.0922	-0.7366	-0.6858	0.127	-0.0508	60.03	71.55
		244.75	122.4026	1.3462	2.9972	1.778	0.1524	0.3794	-0.8128	-1.0922	-0.762	-0.7112	0.1016	-0.0508	58.92	70.22
		200.25	120.6246	1.27	2.8448	1.6764	0.1524	0.254	-0.8382	-1.0922	-0.7366	-0.7112	0.1016	-0.0762	57.78	68.86
		155.75	118.5926	1.1938	2.6924	1.5494	0.127	0.254	-0.8382	-1.0922	-0.762	-0.7112	0.2032	-0.0762	56.47	67.30
		111.25	115.7586	1.0414	2.4892	1.4224	0.127	0.2286	-0.8382	-1.0922	-0.762	-0.7112	0.127	-0.0762	54.68	65.16
		66.75	111.2256	0.8382	2.1336	1.143	0.1016	0.1524	-0.8636	-1.1176	-0.7874	-0.7366	0.1016	-0.0254	51.74	61.66
		22.25	102.2446	0.635	1.6764	0.889	0.0508	0.127	-0.8382	-1.143	-0.7874	-0.7366	0.1016	-0.0254	46.25	55.24
		111.25	109.8826	0.6858	1.778	0.9398	0.0762	0.127	-0.9398	-1.1938	-0.8636	-0.8128	0.0762	-0.0254	50.57	60.63
		222.5	117.9306	0.8636	2.286	1.2954	0.1016	0.2286	-0.889	-1.1684	-0.8382	-0.7874	0.0762	-0.0254	55.58	66.72
		333.75	125.4686	1.2954	2.9972	1.8288	0.1524	0.3556	-0.8382	-1.143	-0.8128	-0.762	0.0762	-0.0254	61.86	72.56
	5 MIN.	333.75	128.7918	1.4224	3.2004	1.9812	0.1778	0.3556	-0.8382	-1.143	-0.8128	-0.762	0.0762	-0.0254	62.97	75.05
	10 MIN.	333.75	129.0966	1.4224	3.2258	2.0066	0.1778	0.381	-0.8382	-1.1176	-0.8128	-0.7366	0.1016	-0.0508	63.17	75.28
	15 MIN.	333.75	129.3114	1.397	3.2258	1.9812	0.127	0.3556	-0.8382	-1.143	-0.8128	-0.762	0.0762	-0.0254	63.36	75.51
		218.05	125.9078	1.27	3.0226	1.778	0.1524	0.2794	-0.8636	-1.143	-0.8128	-0.7366	0.1524	-0.1524	61.10	72.91
		111.25	120.6246	1.016	2.5908	1.4478	0.0762	0.2032	-0.8382	-1.1684	-0.8382	-0.7874	0.0762	0	57.79	68.86
		0	93.7768	0.5334	1.4478	0.762	-0.0508	0.0254	-0.9144	-1.1684	-0.8636	-0.8128	0.0762	0.0254	40.52	48.29
**		0	93.1926	0.5334	1.4478	0.762	-0.0508	0.0254	-0.9144	-1.1684	-0.8636	-0.8128	0.0762	0.0254	40.15	47.85

NOTES:
* MEASURED DISPLACEMENTS ALONG INCLINED PULLING RODS
** RESET DISPLACEMENT TRANSDUCER
*** SEATING LOAD OF 8.9 kN DISPLACED PULLING ROD 152.4 mm
PROCEEDED TO 35 kN LOAD WITH AN ADDITIONAL 31 mm OF SLIPPAGE IN THE PULLING ROD

VERTICAL TELL-TALES NO. T7 AND T17
TELL TALE CONVENTION - SOIL UPLIFT MOVEMENTS INDICATED BY POSITIVE NUMBERS

TABLE C2

RESULTS OF FIELD LOAD TESTING OF INCLINED PLATE ANCHORS

ESSA T9 - PLATE ANCHOR LOAD TESTING
FOOTING NO. 2 NOV.9/82
0.91 m DIAMETER PLATE BACKFILLED WITH NATIVE SOIL
PLATE ANCHOR ROD INCLINED AT 34 degrees (wrt HORIZONTAL)
INCLINATION OF PULLING RODS AT TIME OF TESTING WAS 34 degrees (wrt HORIZONTAL)

HOLD TIME (min.)	APPLIED LOAD (kN)	MEASURED DISPLACEMENTS DISPL. * PULL ROD (mm)	TELL-TALE T8 (mm)	TELL-TALE T7 (mm)	TELL-TALE T9 (mm)	TELL-TALE T10 (mm)	TELL-TALE T11 (mm)	TELL-TALE T12 (mm)	TELL-TALE T14 (mm)	TELL-TALE T13 (mm)	TELL-TALE T3 (mm)	TELL-TALE T2 (mm)	TELL-TALE T1 (mm)	TELL-TALE T16 (mm)	TELL-TALE T15 (mm)	TELL-TALE T18 (mm)	TELL-TALE T17 (mm)	VERT. COMPONENT OF PULL ROD DISPL. (mm)	HORIZ. COMPONENT OF PULL ROD DISPL. (mm)
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
	26.7	3.3528	0	0	0.0254	0.0254	0	0	0	0	0.0254	0.0254	0	0	0	0	0	0.00	0.00
	48.95	3.302	0.0254	0.0254	0.1016	0.0508	0.0254	0	0.0254	0.0254	0.0254	0.0254	0	0	0	0.0254	0.0254	1.87	2.78
	64.525	1.0364	0.0254	0.0254	0.127	0.0508	0.0254	0.0254	0.0254	0.0508	0.0508	0.0254	-0.0254	-0.0254	-0.0508	-0.1016	-0.127	1.85	2.74
	89	5.2324	0.0508	0.0762	0.2286	0.1016	0.0762	0.0508	0.0508	0.0762	0.0762	0.0508	0.0254	-0.0508	-0.0762	-0.0762	-0.1778	-0.2032	1.88	1.68
**	89	5.2324	0.0508	0.0762	0.2286	0.1016	0.0762	0.0508	0.0508	0.0762	0.0762	0.0508	0.0254	-0.0254	-0.0254	-0.0254	-0.0254	-0.0254	2.93	4.34
5 MIN.	89	5.2578	0.0508	0.0762	0.2540	0.127	0.1016	0.127	0.0762	0.1016	0.1016	0.0762	0.0254	-0.0254	-0.0254	-0.0254	-0.0254	2.93	4.34
***	111.25	6.477	0.0762	0.1016	0.381	0.1524	0.127	0.127	0.1016	0.1016	0.1016	0.0762	0.0254	-0.0254	-0.0254	0.0254	0.0254	2.94	4.36
5 MIN.	111.25	7.9502	0.1016	0.1016	0.4064	0.1778	0.127	0.127	0.127	0.1016	0.127	0.0762	0.0254	-0.0254	-0.0254	0.0254	0.0254	3.62	5.37
5 MIN.	133.5	11.0998	0.1016	0.127	0.508	0.2032	0.1778	0.1524	0.127	0.127	0.1016	0.127	0.1016	0.0508	-0.0254	-0.0254	0.0254	4.45	6.59
	133.5	11.938	0.127	0.1524	0.5842	0.2286	0.2032	0.1778	0.1524	0.127	0.127	0.1778	0.127	0.0762	0	0	0.0508	0.0508	6.21	9.20
5 MIN.	155.75	12.9286	0.1524	0.1778	0.6858	0.2794	0.254	0.1778	0.1524	0.1524	0.2286	0.1524	0.0762	0	0	0.0508	0.0508	6.68	9.90
	155.75	14.1478	0.1524	0.2032	0.8636	0.4064	0.381	0.4064	0.2286	0.254	0.2794	0.1778	0.0762	-0.6254	-0.0254	0.0508	0.0508	7.23	10.72
	178	15.1384	0.1778	0.2794	1.0922	0.5588	0.5842	1.0922	0.3556	0.381	0.381	0.254	0.0762	-0.0508	-0.0508	-0.0254	-0.0254	7.91	11.73
**	213.6	20.9042	0.254	0.4064	2.2098	1.3208	1.4224	2.6416	0.9652	0.8636	0.635	0.508	0.127	-0.0254	-0.0254	0	0	11.69	17.33
5 MIN.	213.6	20.9042	0.3048	0.4064	2.2098	1.3208	1.4224	2.6416	0.9652	0.8636	0.635	0.508	0.127	-0.0254	-0.0254	0	0	11.69	17.33
	222.5	21.5646	0.3048	0.4826	3.175	2.032	2.286	4.1148	1.4986	1.2954	0.7874	0.635	0.127	-0.0508	0	0.127	0.1524	11.69	17.33
	249.2	24.6126	0.3556	0.6096	3.7084	2.3622	2.6162	4.572	1.8034	1.5748	1.0414	0.7874	0.2032	-0.0508	-0.0254	0.1524	0.1524	12.06	17.88
	262.55	25.9416	0.4064	0.7112	4.2926	2.7178	3.0226	5.3594	2.0828	1.8034	1.143	0.889	0.2032	-0.0508	-0.0254	0.1016	0.1016	13.76	20.43
	355.875	35.0798	0.4318	0.7366	4.5466	2.8702	3.2004	5.8674	2.2352	1.905	1.1938	0.9398	0.2032	-0.0508	-0.0254	0.1016	0.1016	15.68	23.25
	289.25	32.4358	0.4826	0.889	4.4704	2.6162	2.8194	6.2738	1.8796	1.6256	1.2954	0.9144	0.2286	-0.0762	-0.0254	0.0508	0.0508	16.15	23.94
5 MIN.	289.25	35.179	0.5334	1.016	5.0546	2.9972	3.2258	6.7056	2.1336	1.8542	1.397	1.016	0.2286	-0.0762	-0.0254	0.0508	0.0508	16.14	23.89
10 MIN.	289.25	36.1442	0.5588	1.0414	5.3848	3.2004	3.5052	7.1628	2.3114	2.032	1.4986	1.0922	0.254	-0.0762	-0.0508	0.0254	0.0254	15.67	23.16
	244.75	37.0586	0.5588	1.0668	5.4356	3.2004	3.5306	7.2644	2.3368	2.032	1.4986	1.0922	0.254	-0.0762	-0.0254	0.0254	0.0254	20.21	29.96
	200.25	35.0294	0.5588	1.0414	5.2324	3.048	3.3782	7.2136	2.3368	2.032	1.4986	1.0922	0.254	-0.0762	-0.0254	0.0508	0.0508	20.72	30.72
	155.75	34.3662	0.5334	0.9652	4.9022	2.794	3.1242	7.0866	2.2098	1.8796	1.3462	0.9652	0.2286	-0.0254	0.0254	0.1524	0.1524	20.04	29.71
	111.25	32.1564	0.4826	0.889	4.6228	2.6162	2.9464	7.0358	2.1336	1.8034	1.2192	0.9144	0.2032	-0.0254	0.0254	0.1778	0.1778	19.22	28.49
	66.75	28.0162	0.4064	0.762	4.2418	2.413	2.7432	6.985	2.032	1.7018	1.1176	0.8382	0.1778	0	0.0254	0.2032	0.2032	17.98	26.66
	22.25	27.3558	0.3556	0.6604	3.7846	2.1082	2.4892	6.9088	1.8796	1.6002	0.9652	0.7366	0.1524	0	0.0254	0.2032	0.2032	15.67	23.23
	66.75	21.8186	0.3302	0.635	3.937	2.3368	2.7432	7.3406	2.0066	1.6764	1.016	0.762	0.1524	0	0.0254	0.2032	0.2032	11.96	17.73
	111.25	23.0378	0.3302	0.6604	4.2672	2.5908	3.0226	7.6708	2.1844	1.8542	1.0922	0.8636	0.127	-0.0508	-0.0254	0.0508	0.0508	12.29	18.05
	155.75	24.511	0.381	0.7112	4.6482	2.8194	3.2766	7.9756	2.3368	2.0066	1.1938	0.9398	0.127	-0.1016	-0.0762	-0.0762	-0.0762	12.88	19.10
	200.25	26.797	0.4318	0.7874	4.9784	3.048	3.5052	8.2296	2.5146	2.1082	1.2954	1.016	0.127	-0.1016	-0.0762	-0.0762	-0.0762	13.71	20.32
	244.75	28.9682	0.4826	0.889	5.4102	3.3528	3.8862	8.5852	2.7686	2.2606	1.3716	1.0414	0.1524	-0.127	-0.1016	-0.0762	-0.127	14.93	22.22
	289.25	31.5468	0.5588	1.0414	5.8928	3.7846	4.3942	8.9154	2.9718	2.4638	1.4732	1.1176	0.1778	-0.127	-0.1016	-0.1778	-0.2286	16.16	23.96
	311.5	33.5788	0.635	1.143	6.401	4.048	4.7498	9.1948	3.1496	2.6416	1.5748	1.1938	0.1778	-0.127	-0.127	-0.254	-0.3048	17.64	26.15
	333.75	35.8962	0.7366	1.397	6.8072	4.4196	5.2578	9.4488	3.3528	2.8194	1.6764	1.2446	0.1778	-0.127	-0.127	-0.3302	-0.3556	18.75	27.84
5 MIN.	333.75	37.5936	0.8128	1.6256	7.1628	4.6482	5.5626	9.6774	3.4798	2.9464	1.7526	1.3208	0.1778	-0.1524	-0.1524	-0.4826	-0.508	19.57	29.05
	289.25	37.5936	0.8128	1.6256	7.1628	4.6482	5.5626	9.6774	3.4798	2.9464	1.7526	1.3208	0.1778	-0.1524	-0.1524	-0.4826	-0.508	19.57	29.05
	244.75	37.5936	0.8128	1.6256	7.1628	4.6482	5.5626	9.6774	3.4798	2.9464	1.7526	1.3208	0.1778	-0.1524	-0.1524	-0.4826	-0.508	19.57	29.05
	200.25	37.5936	0.8128	1.6256	7.1628	4.6482	5.5626	9.6774	3.4798	2.9464	1.7526	1.3208	0.1778	-0.1524	-0.1524	-0.4826	-0.508	19.57	29.05
	155.75	37.5936	0.8128	1.6256	7.1628	4.6482	5.5626	9.6774	3.4798	2.9464	1.7526	1.3208	0.1778	-0.1524	-0.1524	-0.4826	-0.508	19.57	29.05
	111.25	37.5936	0.8128	1.6256	7.1628	4.6482	5.5626	9.6774	3.4798	2.9464	1.7526	1.3208	0.1778	-0.1524	-0.1524	-0.4826	-0.508	19.57	29.05
	66.75	37.5936	0.8128	1.6256	7.1628	4.6482	5.5626	9.6774	3.4798	2.9464	1.7526	1.3208	0.1778	-0.1524	-0.1524	-0.4826	-0.508	19.57	29.05
	22.25	37.5936	0.8128	1.6256	7.1628	4.6482	5.5626	9.6774	3.4798	2.9464	1.7526	1.3208	0.1778	-0.1524	-0.1524	-0.4826	-0.508	19.57	29.05
	0	37.5936	0.8128	1.6256	7.1628	4.6482	5.5626	9.6774	3.4798	2.9464	1.7526	1.3208	0.1778	-0.1524	-0.1524	-0.4826	-0.508	19.57	29.05

NOTE:

* MEASURED DISPLACEMENTS ALONG INCLINED PULLING RODS
** RESET DISPLACEMENT TRANSDUCER
*** FUSE BLEW IN XY-PLOTTER DURING TESTING

VERTICAL TELL TALE NO. T7 TO T18
INCLINED TELL TALES NO. T1 AT AN ANGLE OF 81 degrees
INCLINED TELL TALES NO. T2 AT AN ANGLE OF 53 degrees
INCLINED TELL TALES NO. T3 AT AN ANGLE OF 53 degrees

TELL TALE CONVENTION - SOIL UPLIFT MOVEMENTS INDICATED BY POSITIVE NUMBERS

TABLE C3

RESULTS OF FIELD LOAD TESTING OF INCLINED PLATE ANCHORS

ESSA TS - PLATE ANCHOR LOAD TESTING
FOOTING NO. 3 NOV.9/88
1.21 m DIAMETER PLATE CAST IN CONCRETE
PLATE ANCHOR ROD INCLINED AT 34 degrees (wrt HORIZONTAL)
INCLINATION OF PULLING RODS AT TIME OF TESTING WAS 34 degrees (wrt HORIZONTAL)

	HOLD TIME (min.)	APPLIED LOAD (kN)	MEASURED DISPLACEMENTS DISPL. * PULL ROD (mm)	TELL-TALE T2 (mm)	TELL-TALE T1 (mm)	VERT. COMPONENT OF PULL ROD DISPL. (mm)	HORIZ. COMPONENT OF PULL ROD DISPL. (mm)
		0	0	0	0	0.00	0.00
		22.25	0	0	0	0.00	0.00
		44.5	0.2286	0	0	0.13	0.19
		66.75	0.381	0	0	0.21	0.32
		89	0.5334	0.0254	0.0254	0.30	0.44
		111.25	0.9398	0.0254	0.0254	0.47	0.69
		133.5	1.1684	0.0508	0.0508	0.65	0.97
		155.75	1.3716	0.0508	0.0508	0.77	1.14
		178	1.5748	0.0762	0.0508	0.88	1.31
		200.25	2.0574	0.0762	0.0762	1.15	1.71
		222.5	2.4384	0.1016	0.1016	1.36	2.02
		244.75	2.7178	0.1524	0.1524	1.52	2.25
		264.775	2.9972	0.1778	0.1778	1.68	2.48
	5 MIN	289.25	3.302	0.1778	0.1778	1.85	2.74
	10 MIN	289.25	3.429	0.2032	0.2032	1.92	2.84
***		291.475	3.4544	0.2032	0.2032	1.93	2.86
		11.125	1.9812	1.3462	0.4826	1.11	1.64
		89	1.4478	0.0762	0.0762	0.81	1.20
		182.45	2.413	0.1016	0.1016	1.35	2.00
		271.45	3.2766	0.2032	0.1778	1.83	2.72
	5 MIN	271.45	3.3528	0.1524	0.127	1.87	2.78
		224.725	3.2766	0.127	0.127	1.83	2.72
		178	2.8194	0.0508	0.0508	1.58	2.34
		131.275	2.3368	0.0508	0.0508	1.31	1.94
****		131.275	0	0	0	0.00	0.00
		89	1.2446	0	0	0.70	1.03
		44.5	-0.6858	-0.0254	0	-0.38	-0.57
		22.25	-1.7272	-0.127	-0.00254	-0.97	-1.43
		0	-2.9464	-0.3048	-0.02032	-1.65	-2.44

NOTES:
* MEASURED DISPLACEMENTS ALONG INCLINED PULLING RODS
** RESET DISPLACEMENT TRANSDUCER
*** UNLOADED TO 11 kN AND RELOAD IN INCREMENTS OF 90 kN
**** PROBLEM WITH VOLTAGE SUPPLY FOR DISPLACEMENT TRANSDUCERS
NEW ZEROS TAKEN DUE TO DROP OF 0.5 V - ERRONEOUS DATA RECORDED
FINAL ZEROS TAKEN AT END OF TESTING DIFFERENT FROM BEGINNING OF TEST

TABLE C4

RESULTS OF FIELD LOAD TESTING OF INCLINED PLATE ANCHORS

BSSA TS - PLATE ANCHOR LOAD TESTING
FOOTING NO. 4 NOV.8/88
0.91 m DIAMETER PLATE CAST IN CONCRETE
PLATE ANCHOR ROD INCLINED AT 31 degrees (wrt HORIZONTAL)
INCLINATION OF PULLING RODS AT TIME OF TESTING WAS 40 degrees (wrt HORIZONTAL)

	APPLIED LOAD (kN)	MEASURED DISPLACEMENTS DISPL. * PULL ROD (mm)	TELL-TALE T2 (mm)	TELL-TALE T1 (mm)	VERT. COMPONENT OF PULL ROD DISPL. (mm)	HORIZ. COMPONENT OF PULL ROD DISPL. (mm)
**	0	0	0	0	0.00	0.00
**	22.25	0	0	0	0.00	0.00
**	55.625	0	0	0	0.00	0.00
	71.2	1.9304	0	0	0.66	1.48
	93.45	5.588	0.0254	0	1.91	4.28
**	93.45	5.588	0.0254	0	1.91	4.28
	111.25	7.2644	0.0508	0	2.48	5.56
	133.5	10.7696	0.0762	0	3.68	8.25
	155.75	13.3858	0.1016	0.0254	4.58	10.25
**	155.75	13.3858	0.1016	0.0254	4.58	10.25
	178	14.8082	0.127	0.0254	5.06	11.34
***	200.25	17.272	0.1778	0.0254	5.90	13.23

NOTES:
* MEASURED DISPLACEMENTS ALONG INCLINED PULLING RODS
** RESET DISPLACEMENT TRANSDUCER
*** SPECIAL ADAPTOR TO PULLING RODS BROKE DURING THE NEXT INCREMENT OF LOADING

VERTICAL TELL-TALES NO. T1 AND T2
TELL TALE CONVENTION - SOIL UPLIFT MOVEMENTS INDICATED BY POSITIVE NUMBERS